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SOME X-RAY STUDIES OF THE CIRCULATION[1]

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PERHAPS no discovery of modern times has had applications in more divergent scientific fields than have x-rays. Their use in medicine to outline internal organs and foreign bodies is, of course, now a commonplace, but not so many are aware of the assistance of x-rays in studying function. I wish to present the results of some physiologic investigations on the circulation which have been made possible by x-rays.

The circulation as a whole is a device to furnish oxygen to the tissues and to remove their wastes. In accomplishing its purpose, three factors are chiefly concerned: oxygen transportation and utilization, pulse rate, and cardiac output per beat. Two of these concern the heart and are capable of being studied roentgenographically.

A few years ago Henderson bemoaned the fact that three hundred years after Harvey, we still could not answer the simple questions: "How much blood is expelled at each heart beat?" and "How does this vary with pulse rate, venous pressure, rest, exercise, and various other conditions?" Great progress has since been made, but I dare say that if to-day you asked all the students of the circulation to name the one contribution they would most like to make, the answer would be well-nigh unanimous: a simple, accurate method for determining the output of the heart. The heart is a pump, without other physiologic function. If the output of the heart were determined, the clinician could rate the efficiency of the heart with a degree of certainty now entirely unknown.

Harvey, himself, first estimated the volume of the circulation by measuring the capacity of the cardiac chambers in cadavers. In recent times the cardiometer and the Starling heart-lung preparation have been of the greatest usefulness in determining cardiac output in the experimental animal. Although such methods are of extreme importance, they really show only what the heart can do under most abnormal conditions. To secure the circulation volume in the intact animal has proved one of the most difficult problems in all physiology. It was not until the technic of blood gas analysis was developed that the suggestions of Fick, made in 1870, could be carried out. Fick pointed out that, if we knew the O_2 content of arterial blood and subtracted from it the O_2 content of venous blood and divided the total O_2 consumed in one minute by this figure we should have the amount of blood passing through the heart per minute, or the minute-volume of the circulation. On dividing this latter figure by the pulse rate

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we should, of course, have the stroke volume or output per beat.

The Fick principle has now been applied to the respiration of many gases other than oxygen. Nitrous oxide, carbon dioxide, ethyl iodide, and acetylene have proved the most useful. In reviewing the work of those who have used the gas methods, it may be seen that the cardiac output at rest ranges all the way from 3 to 10 liters for minute volume, and from 50 to 160 c.c. for stroke volume. Such variations do not inspire confidence in the gas method as a whole. Its difficulties and limitations are obvious. The necessary co-operation of the patient excludes many subjects, particularly many of those on whom we most desire information. Technically there is always some doubt as to the time required for pulmonary mixing, the solubility of the gas in the blood, and whether or not the samples of alveolar air were secured before the blood carrying the gas had made a round of the circulation.

In view of the variable figures presented by the gas methods, Dr. Eyster and I have attempted to determine heart size and output by an entirely different method, namely, that of the x-ray. The data actually secured are the silhouette areas in the frontal plane.

Many ingenious methods have been devised to interpret cardiac shadows in terms of heart size. Longitudinal and transverse diameters of the ventricles, perpendiculars to these diameters, the shift in position of outline due to a known shift in tube position and area of the shadow have all been used. For experimental, as well as clinical purposes, we believe the silhouette area is most useful.

If the heart were a sphere, it would be easy to deduce the heart volume from its shadow. Although they are not spheres, hearts are similar enough in shape so that the area of the shadow must bear some mathematical relation to the cardiac volume. This matter has been investigated by Bardeen (1), who finds that, with human cadavers, if the silhouette area is comparable with the known volume of that heart, the relationship between the two may be expressed by the mathematical formula, $0.53\ A^{3/2}$, A being the area of the heart shadow. Skavlem (2) in our own laboratory has repeated this study on dogs, and we have recently confirmed his results in a larger series. It appears that in the dog the formula $0.44\ A^{3/2}$ expresses the relationship between silhouette area and volume.

In this way the volume of the heart may be determined from its x-ray shadow within an accuracy of 90 per cent or better. The borders at the base and apex cause some difficulty in man, but in experimental studies of the dog the area is outlined with great ease. Absolute accuracy is, of course, not claimed for the roentgenographic method of determining cardiac volume, but successive measurements are consistent enough to permit one to point out its value in both physiology and clinical medicine.

As it is usually taken, the silhouette area represents the diastolic size of the heart. For many cardiac problems this is sufficient, particularly in the light of Starling's law of the heart. The heart, however, is a pump, and its output is the most important observation that can be made regarding its function. The volume determination just described offers a possibility of reaching this goal.

The intraventricular pressure curve shows that there are two periods in the cardiac cycle in which the heart is a closed chamber, one the period of rising tension when the ventricles are fullest of blood, and the other just after the period of emptying when the semilunars are closed, the auricular-ventricular valves not yet open, and the heart is most nearly empty. If an x-ray film could be taken in each of these periods, the difference in area would be related to the blood ejected.

Although this is not easy to do, it may be

accomplished by a system of keys, circuit breakers, and a plate changer. Closing the primary circuit for the first picture must energize a solenoid circuit breaker which terminates the exposure in about 0.02 second, for the period of rising tension lasts only about 0.04 second. The solenoid of this circuit breaker may also conveniently trip a spring which jerks away the cassette, exposing the next one behind. Closing the primary key also starts a weight falling which closes a second circuit with its circuit breaker, thus making a second x-ray film.

The real problem is to get the first shot placed correctly. Arterial pulsations come too late to be used. It is possible to listen to the heart sounds and trip the switch at the proper moment, but this method has proved cumbersome. The most practical device so far has been to watch the shadow of the electrocardiographic string and throw the switch at the up-stroke of the R wave. The falling body must be so adjusted that it closes the second circuit at the end of the T wave, which is practically identical with the period of falling tension. Induction from the x-ray discharge will cause a short period of vibration in the electrocardiogram, and this conveniently records the exact moment the silhouettes were taken.

So far it must be admitted that the accurate placing of the x-ray films has been largely a matter of chance. To perfect the apparatus the first exposure should be made automatically. Considerable attention has been given to this, but, although Dr. F. J. Hodges, who has worked on these problems with us, has succeeded in amplifying the current caused by the shadow of the electrocardiogram string falling on a photo-electric cell, we have not yet been able to make it throw a switch in the primary circuit without instability and undue lag. It is possible that direct amplification of the heart currents may give satisfactory power.

In spite of all difficulties we have now succeeded in getting satisfactory records from 40 individuals during rest in the erect position. These subjects, all students in good health, had an average cardiac output of 52.1 c.c. per beat. The average minute volume was 4.0 liters. The minute volume per square meter of body surface has not yet been calculated, but it is approximately 2 liters.

On comparing our results with those of other workers, it may be seen that they agree most closely with the recent figures submitted by Grollman (3) who uses the Marshall-Grollman acetylene method. It is of interest to know that Grollman (4) has recently checked his method by making direct output determinations from the O_2 content of blood drawn by needle punctures from the right ventricles and radial arteries of human subjects. Our results, then, are not only of value in giving definite figures on cardiac output, but they help establish the validity of the acetylene gas method.

The chief objections to the x-ray method are the subjective ones involved in outlining and measuring the silhouette areas with the planimeter. In some cases in which the heart rests low on the diaphragm, it must be admitted that the measurements are difficult to make. It has been pointed out by Hamilton (5) that the auricles are filling while the ventricles empty, which also involves a certain error. It is probably for this reason that our measurements have run a little lower than those of Grollman. In spite of these difficulties, the method does show the variation between diastolic and systolic size which may be interpreted in terms of cardiac output. The method is applicable to patients in almost any condition. With improvement in the technic of taking the exposures, we hope it may have definite clinical applications.

One of the questions long debated in physiology is whether or not in exercise the

minute volume of the circulation is increased by size of stroke as well as by increased heart rate. We now have a series of 17 experiments in which cardiac output was determined before and during light exercise. An increased output per beat as well as an increased rate was seen in 14 of the 17. Three increased their circulation by acceleration in rate alone. There are then normal increases in stroke volume. In the experiments cited, these average about 30 per cent. How much greater the increase may be in heavy work, of course, we can not say.

Ordinarily single x-ray films of the heart are taken with exposures long enough to secure the diastolic size. If these silhouettes mean anything to us, we must know some of the factors that determine the diastolic size of the heart. The most important of these is the venous pressure at the heart level. This, in turn, is determined by various other factors, the most important of which is probably the "venopressor" mechanism of Henderson (6). That the heart dilates with a rising venous pressure may be demonstrated in the experimental animal by the injection of a 6 per cent acacia solution, direct measurement of venous pressure low down in the right jugular, and by making simultaneous roentgenograms of the heart. If the rate is controlled, the heart dilates until the venous pressure reaches between 100 and 130 mm. of water, beyond which there is no longer any effect. Within limits, this distention of the heart is a physiologic phenomenon. According to Starling's law, the lengthened fibers should respond with an increased contraction and a larger output. In five dogs we have found this to be the case. In one animal, on raising the venous pressure from 1 to 17 cm., the output as determined by x-rays increased from 9 to 14.9 cubic centimeters. In another, the increase was over 200 per cent.

In the experimental animal, then, the venous pressure is definitely related to heart size and output. There is little doubt that the same relations hold in man. Here, however, we cannot secure the venous pressure at the heart level, but even an increased peripheral venous pressure is usually accompanied by a dilated heart. We have tried to have individuals control their venous pressure by holding the breath, but the accompanying variations in heart rate have obscured the results.

In all studies of diastolic cardiac size, the heart rate has been a complicating factor. A study of this influence has been of interest in the interpretation of clinical films and, theoretically, for its bearing on certain problems of cardiodynamics. It has not always been appreciated that heart rate has an immediate and marked effect on venous pressure. In a slowly beating heart, the output does not keep up with the inflow, the venous pressure rises, and there is dilatation. With a rapid rate, the venous cisterns are emptied, venous pressure falls, and the heart decreases in size. In the dog, rates of from 50 to 100 show little variation in heart size, but, beyond 100, the decrease is rapid and somewhat proportional to the rate until, at 200, the minimal heart size is reached. In man much the same has been found. Hodges, in our laboratory, gave nine individuals atropine, thereby raising their rates to about 130. The silhouettes at the highest rate decreased at times as much as 16 per cent, a figure sufficiently large to have a bearing on the interpretation of a cardiac film. That the rate is not important in itself, but works through its effect on venous pressure, is shown by the fact that, if the venous pressure is held constant by infusion, the rates may vary in animals from 60 to 210 without changing the silhouette area. The period of cardiac filling must, therefore, be shorter than was previously supposed.

After all these factors are studied, the question still remains, What is the normal

area of the heart shadow for any given individual? Differentiation of the enlarged heart from the normal is the most important single thing in the diagnosis of organic heart disease. All but the more uncommon types lead to hypertrophy of the ventricle, particularly the left. Greatly enlarged hearts are, of course, easily recognized. The need is for differentiating hearts less abnormal, at a period when the advancing process may be controlled. The heart is more nearly related to the size of the body than any other organ except the brain. Living hearts, however, cannot be weighed. Recourse must then be had to the x-ray shadow, and the real problem has been to find if, in the normal individual, the dimensions of a heart silhouette can be predicted from any of the body measurements. My colleague, Dr. Eyster (7), in collaboration with Dr. P. C. Hodges and Dr. F. J. Hodges, has devoted considerable time to such studies. By using the formulæ for correlation criteria, they have found that prediction tables may be made for either cardiac area or transverse diameter, based on the age, weight, and height of individuals. The silhouette area, for example, equals Age $\times$ 0.0204 + Stature $\times$ 0.8668 + Weight $\times$ 0.337 — constant 63.8049. From the standpoint of diagnoses, these tables have justified themselves, for, if the percentage variation of 100 normals from the prediction area be compared with the percentage variation of 100 cases of organic heart disease, it will be found that over 90 per cent of these fall outside the normal range. Determination of the cardiac area by the orthodiagram or teleoroentgenogram is thus a practical procedure in cardiac diagnosis. It is of interest to know that introduction into the formula of such factors as girth, area of the lateral plane, lateral diameters, or thoracic measurements have not increased its accuracy.

There is a common belief that athletes have enlarged hearts, but there has been no sufficient study of the matter, so far as we are aware. Eyster (10) has now secured a large series of observations on Wisconsin athletes. The subjects include 83 men and 84 women, all of whom have had athletics throughout their high school course and during two or more years in college. On comparing the areas of this group with the distribution curve of 100 normals, there is no variation from the normal and, therefore, no evidence of hypertrophy. Even with extreme exertion, heart areas of bicycle riders do not usually show marked enlargement, the minute volume being taken care of by moderate dilatation and increased rate. Extreme dilatation of the heart from exercise is probably rare or even non-existent. In one case we were able to secure a film of a student who had collapsed while forcing himself on the stationary bicycle. Much to our surprise there was a smaller heart area than normal. What had happened was doubtless an acute splanchnic dilatation.

The pericardium may be mentioned in this connection since there is evidence that it protects the myocardium from too great dilatation. If x-ray films be taken of the dog's heart with an increasing venous pressure, it will be found that, with an effective pressure of about 15 cm., the heart no longer enlarges. If the pericardium now be slit, the heart at once distends another 20 per cent or more. The protective function of the pericardium under normal conditions would thus seem to be established.

Two things which might be expected to modify venous pressure and, therefore, the diastolic heart size are plethora and hemorrhage. The doctrine of plethora has played an old honorable rôle in medicine. All cardiac dilatations were once plethoric. Although blood volume studies have shown that excess of circulatory fluid is rather rare, we decided to produce it experimentally and to find its exact effect on heart size. Injections of 6 per cent acacia saline were made into the jugular of a dog and, after

the circulation might be expected to be adjusted to its new volume, x-ray films were taken. Much to our surprise we found that acacia solution could be added until the animal's blood volume had increased as much as 100 per cent without enlarging the heart shadow. A typical example was that of a dog weighing 8.2 kilos, which received 800 c.c. of fluid. The heart shadow, which had measured 46 at the beginning, actually measured 43.6 sq. cm. at the end of the injection. In some way, then, the heart is protected from too great an increase in blood volume, and enlargements due to plethora probably never occur. Further study showed that the excess fluid was actually stored in the venules and capillaries.

In regard to hemorrhage, it is obvious that, with loss of blood, the time must come when the fluid returning to the heart is so limited that diastolic size and output must decrease. The interesting question is how much fluid can be withdrawn before this occurs. In 21 animal experiments, we have found that blood equal to 2 per cent of the body weight could be withdrawn before the diastolic heart shadow decreased. Further study showed that the effective circulation was kept up, not only by the entrance of tissue fluids, but by the entrance of blood from the stagnant areas of the capillaries and venules. Bleeding in man has in recent years been practised only sparingly, and generally only in cases of an embarrassed right heart, in which it is a logical procedure. In the light of the experimental results, it must be sufficient to deplete some of the storage spaces before the heart can be relieved. Middleton and Eyster (11) have followed the heart size in man during venesection. Here, too, as in the experimental animal, blood equaling about 2 per cent of the body weight must be withdrawn before the right heart shows a decrease in its dilatation.

Cardiac tonus is another debatable point in circulatory physiology. X-ray silhouettes show no change in heart size during vagal and accelerator stimulation, provided the venous pressure is held constant, which seems to prove that the heart muscle has no tonus under nerve control such as is found in skeletal muscle. Many conditions, however, may increase or lower the ability of the myocardium to withstand intracardiac pressure. A classic example is chloroform, which, even in light anesthesia, markedly reduces the ability of the heart to withstand dilatation.

BIBLIOGRAPHY

(1) Bardeen, C. R.: Am. Jour. Anat., 1918, XXIII, 423.

(2) Skavlem, J. H.: Am. Jour. Physiol., August, 1922, LXI, 501-504.

(3) Grollman, A.: Am. Jour. Physiol., September, 1929, XC, 210-217.

(4) Baumann, Hans, and Grollman, A.: Ztschr. f. klin. Med., 1930, CXV, 41-53.

(5) Hamilton, W. F.: Am. Jour. Physiol., January, 1930, XCI, 712-719.

(6) Henderson, Y.: Jour. Am. Med. Assn., Oct. 31, 1931, XCVII, 1265-1269.

(7) Eyster, J. A. E.: Arch. Int. Med., May, 1928, XLI, 667-682.

(8) Hodges, P. C., and Eyster, J. A. E.: Am. Jour. Roentgenol. and Rad. Ther., September, 1924, XII, 252-265.

(9) Hodges, F. J., and Eyster, J. A. E.: Arch. Int. Med., 1926, XXXVII, 707.

(10) Eyster, J. A. E.: Am. Jour. Physiol., 1930, XCIII, 647.

(11) Eyster, J. A. E., and Middleton, W. S.: Am. Jour. Physiol., May, 1924, LXVIII, 581-584.

DISCUSSION

Dr. Fred J. Hodges (Ann Arbor, Michigan): We have been particularly fortunate in having Prof. Meek with us, for in his paper he has shown clearly that accurate roentgen methods can yield information based upon sound physiologic facts. It is encouraging to know that the methods which we use are accepted by the physiologist as a valuable means of studying certain physiologic functions. He has shown us that the heart size bears a definite relationship to cardiac filling and emptying, and, further, that the methods which we use to determine heart size are fully as accu-

rate, if not more so, than the less direct methods used widely by clinicians. Furthermore, he has shown that roentgen methods compare favorably with older and more widely recognized laboratory methods of making such determinations in animals. All of the procedures which he has described, with the exception of roentgen methods of determining minute volume, are already well known and can be used without difficulty.

THE CLINICAL VALUE OF ROENTGEN MEASUREMENTS OF HEART SIZE[1]

By FRED J. HODGES, M.D., Professor of Roentgenology, University of Michigan, Ann Arbor

ROENTGEN studies of the heart have not, in the past, been looked upon by cardiologists as of any considerable value. To be sure, calcification of the pericardium, foreign bodies within the heart or immediately adjacent to it, gross aneurysmal dilatations of the aorta, dextrocardia, abnormal position of the heart, and gross enlargement have, for some time, been readily recognizable roentgenographically. However, casual observations by the roentgenologists to the effect that in certain cases film studies show an "aortic heart," in others a "mitral heart," etc., have not served to impress the cardiologist greatly. If, however, roentgenologists will report exact area and transverse diameter measurements under standard conditions, including heart rate at the moment of examination and perhaps arterial and venous blood pressure readings; if they will accompany their report with a true sized diagram of the heart in relation to normal landmarks, and will go so far as to compare the measurements thus obtained with predicted normal measurements for the individual in question, their efforts must soon be rewarded by the clinician's recognition of the real value of such assistance.

Numerous methods have been described by various workers for determining the size of the human heart in terms of its various diameters, its area, and its relationship to chest diameter. Of these, perhaps the most widely used is the planimetric, in which a teleoroentgenogram is made at a target-film distance of 2 meters. The frontal plane silhouette and the total transverse diameter value are measured from the right border at its widest point to the midline; the left border is measured at its widest point to the midline, and correction is made for inherent distortion.

Although this method has certain shortcomings, these may be easily overcome by the employment of the method known as orthodiascopy, by the addition of simple and inexpensive accessories to almost any stock fluoroscope. Orthodiascopic studies enable the examiner to combine fluoroscopic examination of the entire chest and the mediastinal structures in the various angles with careful measurements of the frontal plane silhouette. In addition, results are immediately obtainable without the delay occasioned by the processing of photographic films.

Orthodiascopy is a simple method of outlining opaque shadows in their true size without the distortion which always accompanies the x-ray projection of opaque bodies on a photographic film. This is accomplished by recording the position of the tube target

[1]Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, November 30–December 4, 1931.

when a previously determined fixed point in the x-ray beam coincides with various points along the contours of the shadow cast upon the screen. The resulting diagrams are always considerably smaller than the shadow of the opaque object as seen on the fluoroscopic screen, since the screen image produced by projection of a shadow of an opaque object lying in a beam of divergent rays is, of necessity, magnified. Magnification is overcome only when an extremely small portion of the beam, preferably at the center, is utilized.

The operator must learn to use his orthodiascope with reasonable dexterity before the diagrams which he produces will be sufficiently accurate to warrant serious interpretation. Dexterity is readily acquired and the operator can easily check his ability by repeatedly measuring opaque objects of known area and shape. Once a certain amount of skill has been developed, the procedure becomes quite simple and may be employed quickly and accurately. The dotted outline of the cardiac shadow is quickly filled in, giving the exact outline of the heart as seen in the projection. It requires but the work of a few moments to trace the outline with a planimeter, to measure the total transverse diameter, and to compare the figures thus obtained with the predicted normal for the individual in question as obtained from normal heart size tables which have been developed and published (1, 2). The cardiac outline, the level of the diaphragm, the midline of the thorax, and other landmarks can readily be located at the time of examination and incorporated in the final tracing. This tracing, with the area and transverse diameter figures, and the comparison with the normal tables, is then transferred to a piece of letter-size paper. Directly upon this paper the examiner can record a notation of any additional information obtained during the screen examination of the patient. Information should include observations of the width of the retrocardiac space, for narrowing of this space indicates enlargement of the heart in the anteroposterior diameter, usually serving as a further check of frontal plane measurements. Any worthwhile information concerning cardiac and vascular pulsations and the width, course, and length of the aorta may also be included.

P. C. Hodges and Eyster have shown that, if measured cardiac silhouette area exceeds predicted area by as much as 7 per cent, the chances are three to one that cardiac disease exists. Eyster (3) has further shown that a definite relationship exists between the degree of cardiac enlargement and the type of cardiac lesion present. This relationship he has illustrated with scatter curves, demonstrating the distribution of individual case measurements within various groups of lesions in relation to the predicted normal. Further analysis of these curves shows an average cardiac silhouette area, measured for 100 normal cases, 1 per cent below the average predicted area for the same group. In another group of cases, in which accidental systolic murmur constituted the only abnormal clinical finding, the average frontal plane area of measurement coincides exactly with the average normal prediction. In groups of cases known to have specific cardiac lesions the scatter above and below the average measurement is far greater than in the normal group, a fact best explained by the variable age of the lesions and the resultant variable time during which increase in heart size has taken place. Even so it has been possible to group cases fairly well by means of x-ray studies alone.

In reviewing the roentgen findings in a group of proved cases of cardiovascular syphilis, we have been able to show conclusively that no cardiac enlargement existed in several instances of undoubted aortic

aneurysm although cardiac enlargement was suspected by the clinician. Observations of this sort carry considerable weight, especially since they may be repeated on several occasions with but minor variations. Although, in simple mitral stenosis, cardiac area is not ordinarily increased until one or more periods of decompensation have ensued, with the resulting development of mitral insufficiency, orthodiagraphic studies yield pointed information concerning enlargement chiefly restricted to the left auricle. Thus it is possible in a considerable number of cases to recognize mitral stenosis by roentgen methods alone. We now decline to pass judgment in matters of heart size until an opportunity has been offered to permit of more detailed study, as has been described, for orthodiagraphic measurements frequently disprove cardiac enlargement suspected on routine chest examination.

In pericardial effusion, orthodiagraphic studies yield valuable information concerning heart size. The data are of service to the clinician in following the progress of a case, and when they are combined with orthodiagraphic studies and fluoroscopic examination of the heart with the patient lying first on one side and then on the other, they enable the observer to detect with rather great certainty pleuro-pericardial adhesions. It is of importance to recognize the existence of auricular fibrillation when one is making area measurements of the heart, for auricular fibrillation notoriously results in cardiac enlargement. It is of further interest to see the heart size decrease when the fibrillation ceases.

One case of traumatic femoral aneurysm, probably an arteriovenous aneurysm, was recently seen at the University of Michigan. The aneurysm resulted from a stab wound in the right groin below Poupart's ligament, when a short, sharp paring knife was stuck accidentally into the soft tissues at this point. The patient reports that a stream of blood about an inch in diameter poured from the wound without noticeable pulsation, striking the floor about two and one-half feet in front of the patient. When he was seen at the University Hospital, about two months after the original accident, the patient presented, in the right groin, a swelling about the size of a lemon, in which distinct arterial pulsations could be detected and over which a marked systolic thrill could be palpated. When he was standing quietly, the pulse rate was counted at 108 per minute. The blood pressure, measured with a mercury monometer, was found to be systolic 152, diastolic 80. The pulmonic arch, as seen under the fluoroscope, was prominent; the pulsations here were of great amplitude.

The patient had learned that, by exerting digital pressure over the pulsating mass in his groin, he could alter his heart rate and completely obliterate the thrill described. When this was done, the pulse rate promptly dropped to 80-90, and the blood pressure was recorded at systolic 160, diastolic 98. When pressure was applied to the aneurysm during fluoroscopic examination, the prominence of the pulmonic arch was seen to disappear immediately as the amplitude of pulsation was greatly reduced. The frontal plane cardiac area, measured before the aneurysmal sac was obliterated, was 141 sq. cm., or 21.5 per cent above this patient's predicted normal. The transverse diameter figure was 137 mm., or 7.5 per cent above the predicted normal. Following the application of pressure to the aneurysmal sac, the drop in heart rate was found to be accompanied by a distinct increase in cardiac area, to 150 sq. cm., or 29.2 per cent above the normal predicted, while the transverse diameter increased to 142, or 11.4 per cent above the predicted normal.

These observations will serve to indicate the relatively small individual changes in heart size which can be recognized by the methods described. They also emphasize

the necessity for correlating other clinical observations with x-ray studies in order to explain variations which may be noted.

SUMMARY

Heart size measurements made by x-ray methods can be of great clinical importance if the measurements are accurate and if they are carefully interpreted in the light of other clinical findings. Casual statements as to heart size are in all probability of very little real value to the cardiologist. Since methods of accuracy are so readily available, there seems little justification for attempted interpretation without employing them. Tables for the quick computation of normal area and transverse diameter measurements are available which make it possible for the roentgenologist to report directly the extent to which the heart in a given individual varies above or below his own individual normal.

REFERENCES

(1) Hodges, P. C., and Eyster, J. A. E.: Am. Jour. Roentgenol. and Rad. Ther., September, 1924, XII, 252-265.

(2) Hodges, F. J., and Eyster, J. A. E.: Arch. Int. Med., 1926, XXXVII, 707.

(3) Eyster, J. A. E.: Radiology, April, 1927, VIII, 300-306.

HYPODERMOLITHS

WITH REPORTS OF ONE LOCALIZED CASE AND ONE GENERALIZED CASE[1]

By C. E. PIERSALL, M.D., Reno, Nevada

CALCAREOUS deposits in and beneath the skin, which are variable in nature, may be divided into several groups and classifications. These reports and studies will not include: *(a)* the true osteomas of the skin, *(b)* phleboliths and calcified atheromas, *(c)* the secondarily calcified subcutaneous tumors (epitheliomas, fibromas, lupus, tuberculosis, and cysts), or *(d)* the calcified fat lobules on the inner side of the leg, which appear in the aged. The paper will deal with the fifth division of the group made by Broc and Darier, *(e)* calcareous subcutaneous concrements, or calcinosis, which is a rare entity. Although Köhler's "Roentgenology" says that not more than a dozen cases have been reported in the whole medical literature, apparently fifty or more were recorded previous to the publication of his book; some of these reports, however, are brief or incomplete.

This group has been given various names: hypodermoliths, petrification of the skin, lime gout, calcareous subcutaneous concrements, calcinosis, granular deposition of lime, chalk gout, dermal and subdermal concretions, and gout stones.

In the sixteenth century, Trancavella, Ambroise Paré, and Fallopio referred to stony productions in the skin. Incomplete records were made by Richting, in 1834; Vogel, in 1843, and Auvers, in 1851. Wilckens, in 1858, made the first complete study of the subject. In 1900, Renon and Dufour made quantitative analyses in a series of cases of phosphated concrements. Similar studies were made the same year, and have been made since then. In 1911. Thi-

[1]Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1–5, 1930.

bierge and Weissenbach studied the relation of calcareous deposits to sclerodermy, referring to eight cases. In 1925, Gilbert and Pollet surveyed the literature, classified the cases, and noted the difference in the two chemical varieties. Since then a few cases have been reported.

CLASSIFICATION

Histopathologically, these lime deposits, which have been called both granulomas and concrements, frequently seem to be produced at the site of sclerosed tissue which is in a state of hyalin or colloid degeneration. Sclerodermy and diffuse sclerosis of the connective tissues are often found together and are considered to have the same etiology. Similar processes are commonly found in the arterial walls and more rarely as plaques in the myocardium. Apparently, it is agreed that these deposits, and even those found in scleromyositis, are due to faulty calcium metabolism, yet local circulatory or tissue changes coincident with lowered vitality are probably, in some cases, preliminary to the calcification.

The classification may be summed up as follows:

1. Localized:
   (*a*) Non-inflammatory.
   (*b*) Inflammatory, which is secondary to pressure, trauma, or infection.
2. Generalized:
   (*a*) Non-inflammatory.
   (*b*) Inflammatory, which is secondary to pressure, trauma, or infection.
3. Phosphated calcium, total or predominant.
4. Carbonated calcium, total or predominant.

CLINICAL STUDY

Phosphated calcareous concrements are more frequently seen in the female sex. Usually the deposit begins early in life, in the first, second, or third decades, sometimes as early as the first year of life, although one case was reported in a woman in her fifty-third year. The initial seat of the concrements is quite variable. It may be in the tips of the fingers, the legs, the anterior cubital region, the buttocks, the forearm, or the anterior region of the knees. The beginning is always insidious and indolent. Patients sometimes believe the deposits are caused by friction or pressure incident to certain occupations. One scrubwoman, who worked on her knees, developed hypodermoliths anterior to the patellas.

Hypodermoliths are trifling, often renitent, tumefactions, which feign cold abscesses. The covering skin may be normal or thin and yellowish. The tumors gradually harden and enlarge, although some appear to be stony at the onset. While they are mobile on the deep planes of the skin, they are adherent and may even rupture the skin. They number from a single one to several hundred, and they vary considerably in size. In shape they vary from that of a grain of sand to that of a mulberry, with a mammillated appearance, or they may be large spheroid masses. In my generalized case (herewith reported) which presented phosphated and carbonated deposits, one accumulation in the right axilla is spherical, has a separated lower segment, feels like putty, and is about the size of a small orange. This is the largest deposit yet reported.

The localized form is rare, except in adults in whom the affection is usually confined to the fingers or to the scrotum, for, as a rule, hypodermoliths become general after several months or a few years. A degree of insensibility generally persists. Rarely and tardily there are quick shooting pains or repeated muscular cramps, aching in the fullest fingers, and tenderness to the touch. Rather frequently, when the deposits

are near a joint, stiffness may be noticed. Even trismus may occur, as in the case of Renon and Dufour. Amyotrophy, particularly of the deltoid, may be very prominent, and trophic and vasomotor disturbances of the skin are often observed (4).

The evolution of hypodermoliths is variable. Exceptionally they may heal through resorption or through spontaneous expulsion, but, as a rule, they will persist or reappear after ulceration. The skin which covers the tumors ordinarily becomes thin, livid, and perforated, while a creamy paste, similar to dilute chalk or tooth paste, yellowish or brownish in color, appears, which contains minute grains. Cicatrization usually rapidly follows elimination. Sometimes in the generalized cases there is fistulation or suppuration, followed by changes in the general state of health—fever, emaciation, albuminuria, and perhaps intense diarrhea—which, according to Profichet, are due to intestinal ulcerations as was found to be true in the only case of published autopsy.

Carbonated calcareous concrements are also more frequently seen in women, being usually found in the third, fourth, or fifth decades, although two cases were seen in little girls in whom the initial sites were at the extreme end of an upper limb, the forearm, hand, and fingers. The beginning is insidious as in the phosphated variety but functional disturbances are less pronounced. Almost always the carbonated type is associated with scleroderma, amyotrophy is rapid, and sometimes intense pains are felt. but the extension is less considerable and the general condition remains relatively good. Two cases, however, were reported which presented rapid ulcerations and cachexia.

Briefly, the differences in the two types may be summarized as follows:

Phosphated Type

Usually is seen in the first, second, or third decade.

Is of slower development and more prolonged pathologic course.

Is more generalized in form.

Carbonated Type

Usually is seen in the fourth, fifth, or sixth decade.

Less pronounced functional disturbances are present.

Often is localized in form.

Usually is associated with scleroderma.

PATHOGENESIS

Hypodermoliths do not represent a true lime gout as the blood is not overloaded with calcium when this lesion is present. Either a decomposition of soluble salts or a chemical combination with other substances produces the precipitation. The acid base equilibrium and the alkaline reserve were normal in the case reported by Weissenbach, Vignal, and Guillemin. Prof. Naegeli found the stools to contain a great quantity of calcium in a case associated with scleroderma, while in my generalized case it is decreased. The blood cholesterol is often increased but in my cases it is decreased. The basal metabolism increase from 20 to 45, in most general cases, brings in an element-in-figures indicating neuro-endocrine or at least endocrine involvement. Umber says precipitation may occur by common salt in the lime-containing healthy cells during production of lime metabolism or assimilation and pathologic retention may result. W. S. Shutze says that normal cells are free from lime because they produce carbon dioxide—the calcium carbonate and the phosphate going into solution—and that only when this production ceases would calcification set in. Umber and W. B. Schmidt believe this disease to be an assimilation disorder. Dr. Tashiro, a biochemist of the University of Cincinnati, says that calcium may be deposited by local production of ammonium or other base-forming compounds. Morse suspected a pancreatic change which

may have caused a lipolytic ferment because the subcutaneous fat was necrosed and located in and about the calcium deposits in the case which he reports of a three-and-one-half-year-old girl. This seems likely as his case showed atypical subdermal stones in atypical locations.

The mode of formation of these deposits is not understood. Unna believes the origin to be in the sudoriferous glands or in the adjacent subcutaneous tissues. Lewinski thinks it possible that they begin as limited lymphangiomas, while Derville can see no connection with the lymphatics. Milian and Profichet believe that there may be a special infectious disease and that probably there is a cutaneous coccidiosis which would account for some inflammatory cases. The hypothesis of a metabolic calcareous dyscrasia probably associated with thyroid, parathyroid, thymus, and nervous disturbances, would seem to explain the deposition of lime salts in a general way, whether the deposit begins in one cutaneous or subcutaneous structure or another. The metabolisms of phosphoric acid and calcium are intimately connected. Normally, the content of phosphorus in the blood serum is from 30 to 40 mg. per liter, being rather constant. The blood calcium is remarkably constant, being about 100 mg. per liter of plasma. The fixity of this blood calcium is determined by the regulating mechanism of the deposits and of the calcic excretion, which seems to be secured on one hand by the sympathetic or visceral nervous system, and on the other hand by the endocrine glands.

PATHOLOGY

In some cases there is no trace of inflammation, only soft or hard calcareous deposits are noted, located chiefly in the subcutaneous tissue, surrounded by a pseudocapsule formed of connective fibers. The stratum granulosum may present five or six layers; the thickened stratum lucidum also shows visible uniting filaments. In the hypoderm the collagenous fibers are thin and drawn out (Weil and Weissmann-Netter). In the inflammatory variety a cut surface shows a convoluted appearance, the center showing a grainy, amorphous matter (Profichet), or a creamy softened contents which becomes chalky when dry. This substance is surrounded by a hull which contains mast cells, embryonic cells, and long connective cells. Surrounding it there may be dilated lymph spaces and enlarged capillaries, some of which are hyperplastic and even occluded. Adjacent oil or sweat glands may be distended or cystic, yet biopsies failed to show glandular tissue (25). Possibly the inflammatory changes may be found in any case after a certain degree of deposition has produced pressure and trauma or after infection has accidentally occurred following spontaneous or surgical drainage. Nageotte says the connective tissue changes are homogenization, hyalinization, fibrosis, and calcification.

DIAGNOSIS

In well developed cases, diagnosis may be made by physical examination and the history. Roentgen-ray examination, which alone is sufficient, shows little groups of sharply delimited, punctate, streaky, spheroid, or mammillated densities which are usually in and just beneath the skin, in isolated and usually irregular positions. The phalanges may be decalcified, but the joints are unaffected. Osseous sequestra, chronic hygromas, and secondarily calcified tumors should be differentiated by this method especially if a bit of history is correlated. Phleboliths in the abdomen or extremities, hemangiomas, calcified scars, thrombi, and hyaline masses cast similar shadows. Gouty tophi or uratic deposits have characteristic sites of predilection and they are much less dense than hypodermoliths, as we

note roentgenographically. One may exceptionally think of an atypical form of Recklinghausen's disease, or frequently of a scrotal atheroma. Remains of iodoform-glycerin injections, also iodipin and even dermatol, salvarsan, mercury, and bismuth preparations produce roentgenographic shadows. Rarely calcified trichinæ and cysticerci may be seen in the muscles. In early cases of myositis ossificans definite shadows appear symmetrically on both sides of the body, being usually associated with macrodactylia. Chemical examination of the deposits may serve to differentiate in doubtful cases.

TREATMENT

In localized types or local areas, surgical drainage or ablation provides relief from the ache which may be considerable in the much affected parts, especially the finger tips. If the blood calcium or phosphoric acid is high, the diet should be chiefly meat to avoid calcium-rich food. A number of reported cases exhibited hyperthyroidism and one hypothyroidism. The good effects of treatment with various opotherapeutic medication justify us in this form of therapy. Since adrenalin lessens calcemia, but, in turn, increases phosphatemia, it cannot be considered useful, except perhaps in the carbonated variety. C. H. Rabl used ammonium chloride internally to decalcify artificially the bones for the purpose of reducing malformations; but from this (Rabl's) method of decalcification one would not expect much benefit because of the attending poor local circulation and because of the fibrous hull about the hypodermoliths. Also the process of decalcification might produce greater deposition in the superficial tissues, as was found after bone resorption in a case of infection of the metacarpals (11).

Acetycholine has apparently cleared up more sclerodermas than any other remedy. Naegeli lowered the amount of calcium in the blood with a parathyroid preparation, parathormone (Collip), and it seemed to lead to improvement in some cases which had not responded to pluriglandular, ovarian, or thyroid extracts. Ducasse found cholesterol in the concretions; he also found an abnormal amount in the blood, which he combated by reducing the fats in the diet, with apparent cessation of the deposition. Likewise the calcemia and phosphatemia may be decreased by limiting the vegetable and milk rations. He also found that radium liquefied the deposits and caused them to be expelled. Poultices, wet dressings, or soaking in soap solution for from twelve hours to several days has likewise caused softening and drainage. Fair results may be obtained with iodides. General eliminative measures should be instituted. My generalized case is being given X-ray treatments to the thyroid and poultices to the fingers. The localized case is having the hypodermoliths removed surgically one at a time.

REPORT OF CASES

Generalized Type.—Case 1. Mrs. T. L. H., age 58 years, was referred by James Thom, M.D., for X-ray examination of the fingers. Unusual shadows were seen by several roentgenologists, but were first recognized by Dr. Leaf, Associate Roentgenologist at Stanford University Hospital.

Family History.—The patient was the ninth child in a family of six girls and three boys. The father died at the age of 40 years of stomach trouble; the mother died at the age of 65 years of an unknown cause. One brother died of stomach trouble and one sister died at the age of 60 years of leakage of the heart.

Personal History.—The patient, who gives her occupation as that of housewife, was born in Ireland, and lived there for fifteen years. From the ages of 15 to 27

years (1886 to 1908) the patient lived in Colorado; from 1908 to 1930 in Nevada. She is of blond complexion. Her maximum weight was 122 pounds, at the age of 18.

Catamenia.—Puberty was attained at 12 years of age, and the menopause at 47, 11 years previous to examination.

Previous Illnesses.—The patient had had diphtheria in 1889, resulting in left partial paralysis of the vocal cords. Her voice has been weak since. In 1923 she began noticing lumps in the buttocks. Those just anterior to each ischial tuberosity were removed and sent to a pathologist who, however, did not classify them. The left hip began to be painful in 1924, and the next year the right wrist and the hands were swollen for three or four weeks. In 1927 the woman had erysipelas of the face in an aggravated form. In 1929 the skin covering the deposits in the left greater trochanter region opened and drained, for one year. At this time the patient was ill, remaining in bed for three or four weeks, with a temperature of 103° F. Nasal discharge and catarrh had been present from the year 1908. Venereal disease was denied.

Present Illness.—The first manifestations of the present illness were lumps in the buttocks. The finger tips are enlarged and some are scarred, sensitive, and painful. The patient feels nervous, toxic, and stiff.

Habits.—Coffee, 2 cups per day; no alcohol, no tobacco, no drugs. Patient is constipated.

Physical Examination.—Eyes—negative, but the patient is myopic and uses glasses for reading. Ears—normal except at times a feeling of fullness in the left ear and the nostrils. Fullness is felt in the drums and canal at times. There is a small chalky deposit on the rim of the right ear. The woman suffered from dizzy spells for a few months previous to examination. Nose—considerable watery discharge is present and there is post-nasal drainage, causing cough.

Fig. 1. Hypodermoliths near trochanter and ischial tuberosities; also plaques in skin above left buttock.

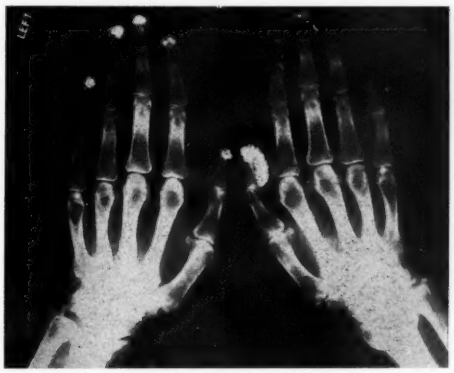

Fig. 2. Soft and hard deposits at tips of thumbs and all fingers; note osteoporosity.

There is a large perforation of the septum, with black scales on its margin. The left nostril has lessened air space. Teeth—complete lower plate and partial upper; remaining teeth normal. Extractions were done in 1925. Appetite—good. Genito-urinary system—nocturia two or three times if fluids are taken with evening meal; no blood; no pus or retention. The last menstrual period was in 1918, at 46 years of age. Height, 5 feet, 3 inches. Weight, 96 pounds, deducting clothing. The woman is of the slender, thin-faced type. Large veins are seen in both the thighs and legs; puffiness is present distal to each external malle-

olus; movable hypodermoliths are present at the inner side of the left knee. There are scars of operation on each buttock and four scars about the left trochanter. There

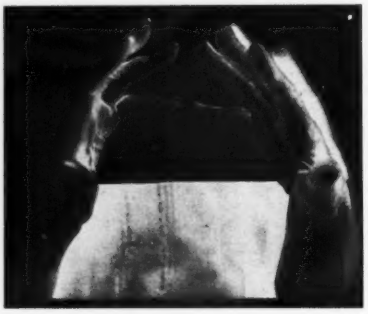

Fig. 3. Photograph of hands; note enlargement of finger tips.

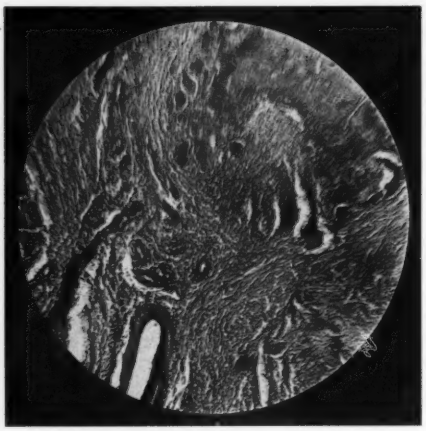

Fig. 4. Photomicrograph through skin, showing calcium deposits (low power).

are plaques under the skin to the right of the right iliac crest. Putty-like deposits are present beneath the skin posterior to the left sacro-iliac joint. The patient's hair has been gray since the age of 40 (her mother was gray at about 50 years). There is a normal amount of hair on the body. The skin is rather dry and atrophic and the woman has not perspired since the year 1923, when she first noticed concretions in the buttocks. Muscles—negative. Tonsils—small. Heart—apex impulse in the fifth interspace; no thrill. Arteries—sclerosis of femorals found by X-ray examination. Radials and axillaries—negative. Blood pressure: 184 systolic; 108 diastolic. Abdomen—negative. Extremities—joints are mobile, with lower bilateral varicosities of pronounced degree. Thumbs and fingers—full at and near ends on palmar aspect, with a few scars of puncture and sinuses. At the margin of one nail and on one finger tip are small yellowish-white deposits beneath the epidermis. The palmar part of the right thumb is about double in size, compressible, but tender. The other fingers are more firm. The skin adheres to the masses. Color is normal when warm, purplish when cool, and white when cold.

Personal Impressions. — The patient thinks the condition is caused by intestinal toxemia, as she feels well only after a cathartic has acted. Enemas cause pain low in the middle of the abdomen.

Reflexes.—Patellar, triceps, biceps, and Achilles—negative. Wrists—present, equal, and active. Abdominal—negative. There is neither knee nor ankle clonus. Babinski's reflex, Oppenheim, and Romberg signs—negative.

Roentgen Findings.—These are shown in the reproductions of films and their accompanying legends. In addition, there are subcutaneous concretions on either side of both knees, particularly on the inner side of the left knee joint, and on the upper leg; calcifications in varicose veins of the legs and thighs, of the costo-vertebral cartilages, and the tips of the transverse processes of the lumbar vertebræ. One toe contains a large deposit at its tip.

Pathologic and Clinical Laboratory Examinations.[2]—Urine—normal, except for diminished phosphates and a few squamous epithelial cells. Feces—normal. No abnormal cells, bacteria, or parasites; no bile or blood is present. Basal metabolic rate

[2]Made by Arthur L. Grover, M.D., Reno, Nevada.

—plus 24. Blood count—hemoglobin, 90 per cent; color index, 0.9; clotting time, 3 minutes, 25 seconds; red blood cells, 4,600,000; white blood cells, 8,200; polymorphonuclears, 63 per cent; lymphocytes, 25 per cent; large lymphocytes, 1 per cent. Considerable achromia is present.

Chemical Blood Examination

		Normal
Blood sugar (dextrose)	147.06 mg. per 100 c.c.	85 to 110
Creatinine	2.86 mg. per 100 c.c.	1 to 2
Uric acid	3.09 mg. per 100 c.c.	2 to 3
Non-protein nitrogen	40.28 mg. per 100 c.c.	25 to 30
Urea	41.92 mg. per 100 c.c.	10 to 15

The bilirubin was shown by the Van den Bergh test to be diminished.

Biopsy.—A section of the palmar region of the right thumb, $3.5 \times 1.5 \times 1$ cm., was taken for biopsy. The flat, or cut, surface showed a hard, firm mass of tissue full of more or less fused, white, calcified areas. Microscopically, there was a normal appearing epidermis beneath which the dermis showed dense and fibrosed. The blood supply seemed to be subnormal. The few blood vessels present appeared to have hyperplastic walls, due to an increase in the amount of fibrosis, particularly of the endothelium. There were numerous, somewhat dilated, capillaries and lymph spaces scattered throughout. In several places there seemed to be collections of lymph cells undergoing a marked fibrosis which may have been the remains of lymph nodes. Some of the cells in these had taken up calcium and retained it, while in other places there were marked deposits. In all of these places the salt appeared to have been first deposited in the endothelial cells about the blood or lymph spaces. From these locations the material was deposited in rather large masses; by the fusing of these, still larger masses have been formed until the appearance of larger dermoliths was obtained, as shown by gross examination. These act as any foreign body, stimulating the surrounding connective tissue to hyperplasia, so that the deposits become fairly well walled off. By the resulting pressure rather compact calculi have been formed, which may be shelled out.

Biologic Examination[3]

		Normal
Blood Serum (Untreated)		
Calcium* (as Ca)	13.2 mg. per 100 c.c.	9 to 11
Phosphorus** (as P)	4.9 mg. per 100 c.c.	3 to 4
Blood (Oxalated)		
Cholesterol†	115.0 mg. per 100 c.c.	150 to 190
Deposit		
Microscopic appearance	white, non-crystalline masses	
Cholesterol‡	present	
Total weight of sample	7.7 mg.	
Residue after washing	5.3 mg.	
Ash on sample	68.84 per cent	
Ash constituents		
Calcium* (as Ca)	39.81 per cent	
Phosphorus** (as P)	16.03 per cent	
Carbonates	present	
Hypothetic combinations in ash		
$Ca_3(PO_4)_2$	80.15 per cent	
$CaCo_3$	21.97 per cent	
Stool		
Ash, on moisture-free sample	10.61 per cent	
Ash constituents		
Calcium†† (as Ca)	2.17 per cent	
Phosphorus‡‡ (as P_2O_5)	37.76 per cent	

Localized Hypodermoliths. — Case 2. This condition was discovered incidentally by inspection, when the patient submitted himself to me for galvanic therapy for pruritus ani, hemorrhoids, fissure *in ano*, and for ultra-violet radiation for tinea vesicolor. Upon recognizing this as a localized case of hypodermoliths, I made roentgenographic examinations of the extremities, pelvis, and abdomen but found no evidence of calcareous deposits, except those in the scrotum.

Family History.—The parents are living and in good health. Six brothers and three sisters are also living and well.

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[3]Made by M. R. Miller, Chemist at the University of Nevada.

*Determined by Clark and Collip modification of Kramer-Tisdall method. Jour. Biol. Chem., March, 1925, LXIII, 461-464.

**Determined by Fiske and Subbarow modification of Bell-Doisey method. Jour. Biol. Chem., 1925, LXVI, 375-400.

†Determined by method of Meyers and Wardell modified, Hawk and Bergeim, Practical Physiological Chemistry. P. Blakiston's Son and Co., Philadelphia, ninth edition, 391, 392.

Meyers and Wardell: Jour. Biol. Chem., 1918, XXXVI, 147.

‡Qualitative test for cholesterol by Liebermann-Burchard reaction.

††Determined by McCrudden's method. Jour. Biol. Chem., 1910, VII, 83. Also 1911, X, 187.

‡‡Determined by uranium acetate titration.

Personal History.—The patient who is 41 years of age weighs 195 pounds, is of blond complexion and has blue eyes. He had pneumonia at the age of 12 years and influenza several times prior to 1914. He has lived in the southern part of the United States most of his life.

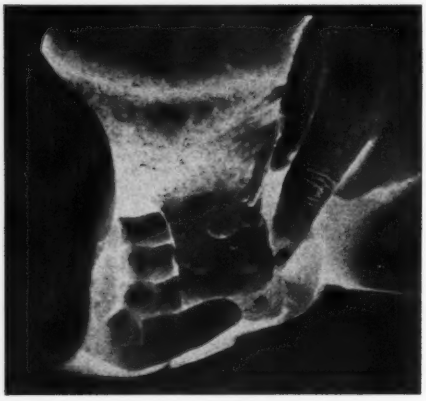

Fig. 5. Case 2. Photograph of scrotum, showing skin stretched.

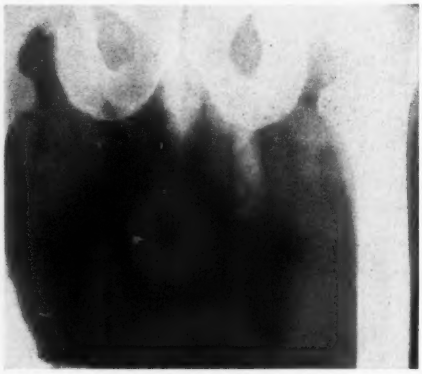

Fig. 6. Case 2. Localized case, showing few of stones in scrotum.

Present Condition.—About the age of puberty this man began to have small pustules, simulating acne, on the scrotum. He kept them empty for some time by evacuating them, but for several years he had left them alone, until at examination they presented the appearance of calcified, hard, white, oval, cystic masses just beneath the skin. They could be enucleated, sac and all, by slitting the overlying skin. The physical examination was otherwise negative.

Habits.—Coffee, about one cup per day; no alcohol, no drugs. The patient has smoked a pipe and cigars for the past five years. He partakes of a mixed diet; is slightly constipated but has one or more stools daily, absolutely at will. He perspires freely.

Laboratory Examination.—The urine examination was negative except that the specific gravity was 1.022. The chemical blood examination was normal. The Wassermann test was negative.

Biologic Examination

Blood Serum (Untreated)

Calcium (as Ca)	10.4 mg. per 100 c.c.
Phosphorus (as P)	4.47 mg. per 100 c.c.

Blood (Oxalated)

Cholesterol	126.7 mg. per 100 c.c.

Deposit

Microscopic appearance—white, partly crystalline masses, but indistinct	
Macroscopic appearance—a white, hard mass in an envelope of thin tissue	
Weight of sample	0.4272 gm.
Weight of sample, dried	0.4154 gm.
Organic matter	present
On ignition of dry sample	15.44 per cent
Calcium*** (as Ca) on dry sample	33.05 per cent
Phosphorus (as P) on dry sample	10.30 per cent
Cholesterol on dry sample	0.28 per cent
Hypothetic constituents of dry sample:	
Calcium carbonate ($CaCO_3$)	32.74 per cent
Calcium phosphate ($Ca_3(PO_4)_2$	51.48 per cent
Organic matter	15.44 per cent

REMARKS

In my generalized case both the skin and bowels are quite under-active, the patient never feels well except after a cathartic has acted, and she has not perspired since the first signs of the deposits, which were found in the lower part of the buttocks in 1923. As the urine examination was normal, the increased end-products found in the blood indicate poor skin function. Her blood calcium and phosphorus are a little high, while the cholesterol, as in the localized case, is low. The stool contains a decreased amount

***The methods used are as given in Case 1.

of calcium, but the normal amount of phosphorus. While Gilbert and Pollet say that cholesterol is never found in the deposits, it is found in both the generalized and the localized cases cited here and it was also reported in one other, Ducasse's case. In the

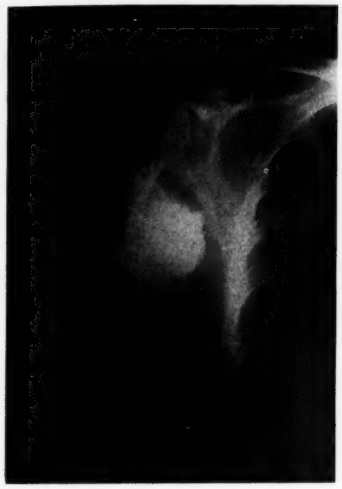

Fig. 7. Case 1. Large putty-like mass in axilla (it had not been noticed by patient).

localized case, the blood calcium and phosphorus, and the composition of the deposits, are similar to those of the generalized case. Both belong to the phosphated variety. The generalized case is one of the oldest of these patients on record. She has the largest deposit reported and is the only case I have found in which all fingers and both thumbs are involved.

ADDENDA

Progress of Cases.—No treatment was given the localized case.

We administered to the generalized case the following roentgen treatments:

Nov. 20, 1930: 1 E.D. to the entire thyroid gland.

Feb. 19, 1931: 1 E.D., as before.

March 19, 1931: ½ E.D., as before.

On April 30, 1931, the patient's blood pressure was 150 S. and 90 D. as compared with 184 S. and 108 D. before treatment. Her weight had increased from 96 pounds to 109½ pounds, and she was no longer nervous.

On Aug. 22, 1932, her weight was 119

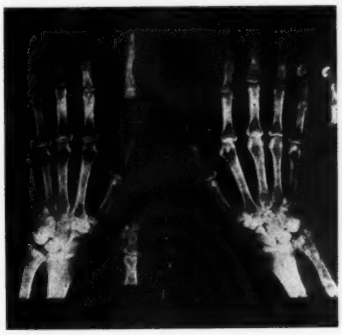

Fig. 8. Reproduction of Busi's case.

pounds, there was no nervousness or discomfort, and the calcific deposits were apparently unchanged, indicating that the process of calcinosis had ceased. The improvement in the general health is accounted for by the reduced activity of the thyroid and coincidentally the parathyroid glands, as a result of roentgen radiation.

BIBLIOGRAPHY

1. Weidman, Fred W., and Shaffer, Loren W.: Calcification of the Skin, Including the Epiderm, in Connection with Extensive Bone Resorption. Arch. Dermat. and Syph., November, 1926.
2. Ducasse, R. E.: Calcification of the Skin, with Unusual Findings. Arch. Dermat. and Syph., March, 1923, VII, 373-375.
3. Malherbe, Lewinski, and Unna: Reference Hand-book of the Medical Sciences. Vol. III, page 223.
4. Weil, M. P., and Weissmann-Netter, R.: Subcutaneous Calcified Nodules and Thyro-ovarian Insufficiency. Ann. de Dermat. et Syph., December, 1924, V, 724-732.
5. Rabl, Carl H.: Arch. f. klin. Chir., 1924, p. 211.
6. Busi, Aristide: A Case of the Disease which is Known under the Name of "Stones of the Skin." Bull. delle Sci. med. di Bologna, May, 1907.
7. Morse, J. L.: Calcification of the Skin in a Child. Am. Jour. Dis. Child., October, 1921, XXII, 412.
8. Logan, J. R.: Unusual Calcareous Deposits in the Soft Tissues of the Hands. Arch. Ra-

diol. and Electroth., July 28, 1923, XXVIII, 55, 56.

9. WEIDMAN, F. D., and SHAFFER, L. W.: Calcifications of the Skin, Including the Epiderm, in Connection with Extensive Bone Resorption. Trans. Sect. Dermat. and Syph., Am. Med. Assn., 1926, p. 220-240.
10. GILBERT, A., and POLLET, L.: Paris méd., Oct. 31, 1925, p. 345.
11. WEIDMAN, F. D.: Osteomyelitis Followed by Calcareous Resorption and Deposit in the Soft Tissues. Atlantic Med. Jour., December, 1926, XXX, 163.
12. SNETLAGE, A.: Case of Sclerodactylia with Subcutaneous Calcium Deposits. Neder. Tijdschr. v. Geneesk., Sept. 3, 1927, II, 1075.
13. KÖHLER, ALBAN: Röntgenology: The Borderlands of the Normal and Early Pathological in the Skiagram. William Wood and Co., New York, 1928, pages 9, 10.
14. SCHUTZE, W.: The Granular Deposition of Lime in the Skin. Dermat. Wchnschr., Jan. 8, 1927.
15. SCHOLTZ, W.: On the Deposition of Lime in the Skin. Dermat. Wchnschr., March 26, 1927.
16. WEISSENBACH, R. J., VIGNAL, E. W., and GUILLEMIN, C. O.: Concrétions Calcaires Souscutanées des Doigts, Associées a une Acrocyanose Permanente avec acces d'Acrocyanose Paroxystique (Raynaud's Syndrome), A Biochemical Study. Bull. Soc. franç. de Dermat. et Syph., July, 1929, XXXVI, 910.
17. THIBIERGE, GEORGE, and WEISSENBACH, R. J.: Subcutaneous Calcareous Concretions, Sclerodermy, and Metabolism. Paris. méd., Jan. 23, 1926.
18. PETGES, G.: Case of Alternate Hemiscleroderma of Face, Trunk, and Limbs in a Heredosyphilitic. Dermatologic Soc., Strassburg, séance of May 26, 1929. Bull. Soc. franç. de Dermat. et Syph., pp. 880-883.
19. PETGES, G., LECOULANT, P., and DELAS, P.: The Sclerodermies. Bull. Soc. franç. de Dermat. et Syph., pp. 877-880.
20. NAEGELI: Regarding Sclerodermies. Bull. Soc. franç. de Dermat. et Syph., pp. 883-888.
21. LEVY, GEORGES, and ZORN: Sclerodactylia "without Affecting Hands." Bull. Soc. franç. de Dermat. et Syph., pp. 888-891.
22. BUBREUILH, M. W.: Concerning Sclerodermy. Bull. Soc. franç. de Dermat. et Syph., pp. 891, 892.
23. HUFSCHMITT: Four Cases of Sclerodermy. Bull. Soc. franç. de Dermat. et Syph., July, 1929, XXXVI, 892-899.
24. HUDELO and RABUT: Two Cases of Progressive Sclerodermies (Differential Diagnosis with Leprosy). Bull. Soc. franç. de Dermat. et Syph., July, 1929, XXXVI, 899.
25. LORTAT-JACOB, FERNET, P., and BUREAU, Y.: Cutaneous Atrophy with Scleroderma, Melanoderma, and Calcareous Concretions. Hypercalcemia and Increase of the Basal Metabolism. Bull. Soc. franç. de Dermat. et Syph., July, 1929, XXXVI, 902-906.
26. PUSEY: The Principles and Practice of Dermatology. Page 1025.
27. ORMSBY: Diseases of the Skin.
28. Endocrinology and Metabolism. D. Appleton and Co., New York, Vols. I, II, III, IV.
29. SUTTON: Diseases of the Skin. Page 573.

AN X-RAY SIGN IN THE DIAGNOSIS OF REDUCIBLE ESOPHAGEAL ORIFICE HERNIA[1]

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THERE has been an increasing interest in diaphragmatic hernias during the past few years. This is due, in part, to the fact that the clinical manifestations of the condition are manifold, often simulating and being mistaken for other, and usually more serious, intra-abdominal conditions. There is also a growing suspicion among some clinicians that diaphragmatic hernias may sometimes cause a severe, obscure anemia. The literature has now assumed sizable proportions. The clinical, developmental, and roentgen features have been well considered at length.

Most of the recent observers stress the point that diaphragmatic hernias, particularly those through the hiatus, are still being overlooked in spite of the wide use of x-ray methods. These authors also call attention to the importance of a thorough examination in the various horizontal positions, if this condition is suspected. Owing to the limitations of time, space, and apparatus, many small laboratories, and not a

[1]Read before the Radiological Society of North America, at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1–5, 1930.

few of the larger clinics, do not make such studies routinely. Moreover, some diaphragmatic hernias, even in the horizontal position, can be demonstrated only by prolonged and repeated examination. The importance of the lesion does not warrant making such a long-drawn-out routine search with all gastro-intestinal cases in a busy clinic. Any sign in the vertical position calling attention to the possibility of a diaphragmatic hernia should be of value.

Gray, discussing the comprehensive article of Ritvo, suggested that it is absolutely impossible to diagnose or even suspect reducible orifice hernias with the patient in the vertical position. This is the type most apt to be overlooked during the roentgen examination, at the operating table, and even during the postmortem.

The esophagus in the lower third forsakes its close relation with the spine, curving laterally and forward to pass through the hiatus esophagi of the diaphragm, and thence to reach the stomach at a rather acute angle. This portion of the esophagus is normally capable of respiratory motion, traveling to the midline and forward on inspiration. The stomach, which hugs the medial half of the diaphragm closely, is in an excellent position to herniate, if there be an opportunity to do so.

The stomach migrates downward, as does the diaphragm, and the esophagus lengthens to permit this descent. Failure of the esophagus to do so for any reason causes a portion of the stomach to extend through the diaphragm. This hernia, known as the short esophagus type, has been well described by Akerlund and Anderson. If the patient assumes an upright position, there is no opportunity for a reduction. This hernia is excessively rare and has identifying characteristics of its own. The diaphragm originates to a large extent in the septum transversum, originally a cervical structure, the sternal portion of which gives rise to the pars costalis and sternalis of the diaphragm, while the dorsal portion gives rise to the pars vertebralis of the diaphragm. The hiatus esophagi is formed as a space between two muscle bundles, or groups, of the diaphragm arising from the spine. Lack of or imperfect development of these muscles gives an opportunity for herniation to occur, which in our experience has consisted only of the stomach.

Fig. 1. This radiograph of a small, reducible, esophageal hiatus hernia was made in a horizontal position. The line indicates the course taken by the barium as it ran into the stomach. Although when the patient was in the upright position the hernia reduced, the same curve was present if the patient swallowed the barium on full inspiration.

A perusal of the literature and a study of these cases will show that redundancy and abnormal mobility of the esophagus are not uncommon. As the stomach herniates through the hiatus, one of two things probably happens: the involved portion of the stomach may pull the end of the esophagus

along with it sufficiently to make an upward curve, or there may be a direct pressure against the esophagus, causing the redundant portion to buckle and thus describe a curve. This obviously cannot happen with hernia of the short esophagus type, and there is absence of the sign to be described below.

In the erect position, the esophagus and stomach may appear perfectly normal. In such instances, it is often possible, by increasing the intra-abdominal pressure sufficiently, to cause the end of the esophagus to angulate, even though not sufficiently to cause a gas bubble to appear above the diaphragm. Much less frequently we may see abnormal areas of narrowing and hesitation, sometimes with a slight dilation of the esophagus above. Camp has noted a lateral displacement of the esophagus. When present, such findings are an aid in the diagnosis. Intimate knowledge of the normal anatomy of this region is quite essential for the appreciation of these changes.

It is necessary to observe a definite technic. The patient is placed in the vertical right anterior oblique position, the central ray being directed through the gastro-esophageal region, using as small a diaphragm as possible. The ordinary stomach barium mixture is employed. Heavy, thick esophageal suspensions must not be used. The patient is told to take a mouthful of the barium mixture without swallowing and then instructed to inhale deeply through the nose, the head being bent slightly forward. While the breath is held in full inspiration, the patient is told to swallow. In the meanwhile the examiner's right hand is pushed firmly against the anterior abdominal wall. The left diaphragm is watched carefully to see that the patient does not expire ever so slightly as there is some tendency to do on deglutition. Partial expiration will in most cases not suffice to cause distortion of the esophagus. The amount of pressure applied with the hand varies according to the tone of the abdominal muscles, being greater if the latter are soft and flabby. Close attention must be paid to the head of the barium column as it descends. If a hernia is present, the barium stream usually takes an upward course as it is about to enter the stomach. This may be a sustained direction or merely a transitory flip, occurring only when the head of the barium column reaches the region. For obvious reasons, it is difficult to secure an adequate roentgenographic delineation of the movement. The observation is essentially a radioscopic one.

If alteration of the stream is noted, careful horizontal studies in all positions should be made and repeated two or three times, before one may conclude that no hernia exists.

CONCLUSIONS

1. An x-ray sign in the diagnosis of reducible esophageal orifice hernias, depending on the distortion of the esophagus by increased intra-abdominal pressure, is described.

2. A simple routine procedure is outlined whereby the sign may be elicited during vertical radioscopy.

3. The necessity for intimate familiarity with the normal anatomy of the gastro-esophageal region is stressed.

BIBLIOGRAPHY

1. Akerlund, A.: Diaphragmatic Hernia of the Esophageal Hiatus. Acta Radiol., 1926, VI, 3.
2. Anderson, C. C.: Hernia through the Esophageal Opening of the Diaphragm. Radiology, June, 1930, XIV, 602-604.
3. Camp, John D.: Personal communication.
4. Carty, J. R.: Some Radiographic Aids in the Diagnosis of Diseases of the Esophagus and Cardia. New York St. Jour. Med., Sept. 15, 1928, XXVIII, 1111, 1112.
5. Keith, Arthur: Human Embryology and Morphology. Edward Arnold, London, 1921.
6. Ritvo, Max: Hernia of the Stomach through the Esophageal Orifice of the Diaphragm. Jour. Am. Med. Assn., Jan. 4, 1930, XCIV, 15-21.

A ROENTGEN CONSIDERATION OF COMMON CONGENITAL ANOMALIES AS RELATED TO INJURIES

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DEFORMITIES may be congenital in origin or the result of trauma, static conditions, muscular contractures, muscular weakness, atrophy, or paralysis. It is impossible to illustrate all of the congenital conditions that could occur in bones and joints; however, some of the most common ones are very frequently mistaken for injuries and are, therefore, worthy of consideration.

Congenital anomalies are thought to be signs of lowered resistance. This is further proven by a complete check-up of our patients in whom we invariably discover other defects co-existing in bones and joints. Beginning with the vertebral canal, we occasionally see that the coalescence of the laminæ is incomplete. This results in a cleft being formed in the posterior arch of a vertebra with a consequent protrusion of the dura and arachnoid, if the cleft is wide. Spina bifida may be a final outcome. This condition may be so extensive as to involve the posterior arches of all the vertebræ, resulting in an incomplete vertebral canal.

From the orthopedic viewpoint, spina bifida is of interest because of the muscular weakness and deformity of the spine, which may end in a postural curve or extensive scoliosis, with bony changes. Together with the above conditions, we may find such associated conditions as club feet or deformed hips. Complete or partial absence of bones may also exist. Some cases of spina bifida show only a few of the above deformities, whereas in others they are all present. Spina bifida seems to be most common in the lumbosacral and sacral regions (Fig. 1). One not acquainted with this condition may often read fracture in a patient complaining of low-back pain. Awards are frequently given, erroneously, to injured patients because of inability to recognize this condition. There may be an absence of fusion of the laminæ or variations in the articular facets. Another common anomaly is the slight upward tilting and narrowing of the transverse process of one or the other side,

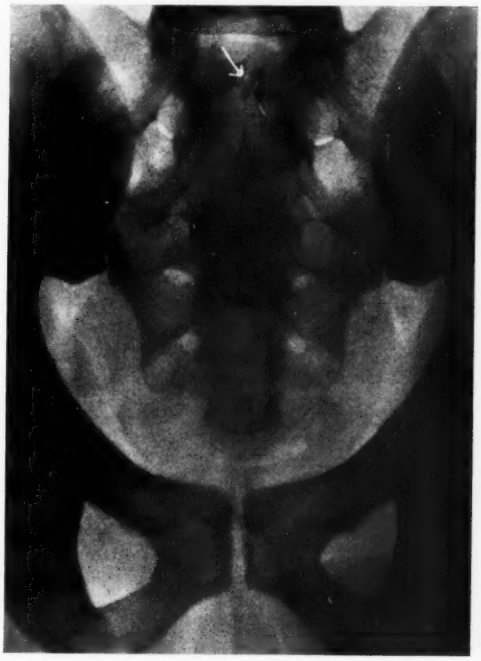

Fig. 1. Spina bifida (congenital) may be mistaken for fracture by one not acquainted with this condition.

which may be further accentuated by the psoas muscle passing over the transverse process, giving the appearance of a fissure fracture. This anomalous condition is very important from a medico-legal standpoint, as it is often mistaken for an injury.

In the cervical region, a frequent anomalous condition is noted. Early in fetal life, the anterior, or costal, part of the transverse process of the seventh cervical vertebra is

sometimes ossified from a separate center. Union occurs with the body and posterior part of the transverse process about the sixth year. If the costal part persists as a separate piece, it lengthens and becomes a

Fig. 2. Congenital absence of the radius.

"cervical rib" with a definite head, neck, and tubercle, extending antero-laterally into the posterior triangle of the neck. It may terminate freely or join the first thoracic rib. Cervical ribs are clinically, as well as roentgenologically, important as they give rise to vague nervous and vascular symptoms, depending on their approximation to the brachial plexus or subclavian artery or vein. One can readily see that slight injury on the arm of a patient may cause a great deal of obscure pain unless "cervical rib" could be ruled out.

Congenital absence of ribs is not uncommon and when it exists there is usually an asymmetry of the thorax. This may also lead to deformities of the spine.

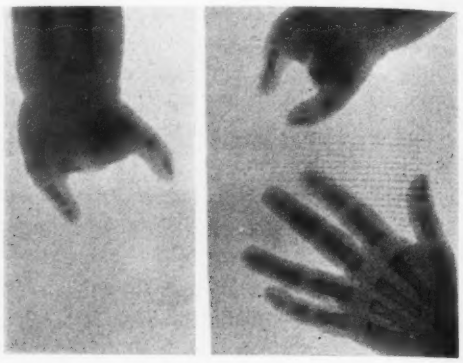

Fig. 3. Undeveloped metacarpals with resulting absence of phalanges.

The transverse process of the first lumbar vertebra is sometimes developed as a separate piece which may remain permanently un-united with the rest of the bone, forming a lumbar rib.

The fifth lumbar vertebra has always been a great source of controversy. Many thousands of dollars are paid by companies carrying compensation for supposed injuries to this vertebra as well as for sacro-iliac strain. Many anomalous conditions occur in this bone. It may be bifid, thus causing improper ligamentous attachments, resulting in weakness and low-back pains. One transverse process may be larger than the other, causing sacralization of either one or both sides.

It is rare to find injuries in the fifth lumbar vertebra, because its massive construction and its position inhibit the occurrence of lesions here. It is surrounded by muscles and ligaments and protected on either side by the ilia. Because the transverse processes

are in close approximation with the iliac bones and, due to the abutment of the transverse process against the ilium, one can readily see that a sudden turning or bending will result in a severe sprain or fracture.

remarkable variations from the normal. Congenital absence of the radius or ulna is not uncommon (Fig. 2).

Total or partial absence of the long bones of the body may exist. In some instances,

Fig. 4. Supernumerary digits.

One can appreciate the precarious position of the fifth lumbar vertebra, placed as it is between the mobile spine superiorly and the immobile sacrum inferiorly.

A malingerer who once has suffered from a genuine injury to the spine may present himself. He may have fully recovered from the injury, and he may realize this fact. Although the effects have in reality disappeared, he may have developed a neurosis which leads him to believe that he is still suffering from these effects. The physician may have some difficulty in determining if the patient has any justification for his complaint of continued disability. There are other malingerers, of course, who claim bad effects from an injury which never took place. Many tests for malingerers are known and used.

Several deformities of the upper extremities are met with. One arm may be represented by a small atrophied structure which may have the bones complete or may show only the epiphyseal line, or growing portion of the bone, is affected, without any apparent absence of the bone. The structures of the leg or arm, therefore, do not grow as they should and as a result deformities of the hand or leg are present. When the humerus or femur is defective the bones are usually deformed. When the bones below are present, there is usually some small bone corresponding to the absent one. If any of the tarsal or carpal bones is absent, the metacarpal or metatarsal bones beyond it are apt to be missing (Fig. 3).

The wrist and hand may be represented by a small fleshy mass with a number of partly ossified bones in its interior, and supernumerary digits may also exist (Fig. 4), which may be unilateral or bilateral.

Very often in cases of injury the astragalus is reported to be fractured when in reality the os trigonum, a common congenital anomaly in the foot, is seen. This is nothing more than a backward extension for a vari-

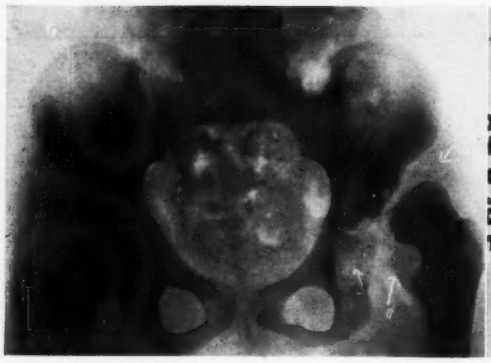

Fig. 5. Congenital dislocation of hip before reduction.

Fig. 6. Reduced congenital hip dislocation.

able length with failure of union. Because of its smooth and even edge, some anomalous condition is usually thought of.

A most frequent congenital deformity is congenital hip dislocation, which may involve one or both hips, and seems to predominate in females. In 801 cases reported by Whitman,[1] 655 were in females and 146 in males. These dislocations are ofttimes submitted in evidence as traumatic and may usually be passed as such if the case is not studied properly. In this condition, the hip may be very slightly dislocated, the femoral head sliding insecurely in the acetabulum, or it may be so markedly dislocated that the trochanter approximates the iliac crests. When the child begins to walk, there is usually a noticeable limp which gradually increases, seeming to be more apparent in a single than in a double congenital dislocation. The trochanters often ride high above Nélaton's line and there is also a shortening of the affected leg. Early in this condition, the capsule allows great freedom of motion. However, as growth progresses, the capsule becomes shorter and limitation is restricted due to the inelasticity of its fibers; the cotyloid ring also becomes narrowed, making reduction somewhat difficult, and, because of the muscular imbalance, lordosis becomes extreme (Figs. 5 and 6).

[1]Whitman: Orthopedic Surgery. Eighth ed., page 831.

Fig. 7. Delay in ossification of the postero-superior iliac spine and dorsal third of the right iliac crest.

A common deformity that the roentgenologist, as well as the orthopedist, meets with is a congenital elevation of the scapula (Sprengel's deformity), involving one or both bones. Many lawsuits have been won and much compensation awarded because of the failure to diagnose this condition. The scapula is elevated and inclined slightly forward and outward, being less movable than normally because of the shortening of the muscles that attach it to the spine or ribs. This high position of the scapula causes a deformity of the neck as well as scoliosis.

Several anomalous conditions are found

in the ossification of the pelvic bones. Besides the three primary centers of ossification present in each hip bone, several secondary centers exist. These secondary centers appear about the age of puberty and, unless their site of appearance is well known, a mistaken diagnosis of fracture will often ensue. Delay in ossification of one of these secondary centers may also simulate fracture (Fig. 7).

CONCLUSIONS

The importance of roentgenograms as an aid to traumatic conditions cannot be emphasized too strongly because of the relationship they bear to the legal aspects of the case. Roentgenograms become invaluable in cases of disputed diagnosis. It is further essential that every X-ray film taken for testimony should show good bone and soft-tissue detail. Physicians very often testify to certain findings in a film that is poorly taken and improperly developed. This often leads to serious consequences involving the patient and also the professional standing of the physician. It goes without saying that physicians offering X-ray testimony should be well able to differentiate between normal, pathologic, and congenital abnormalities existing in the human anatomy. It, therefore, behooves the roentgenologist to consider carefully the possibility of congenital anomalies existing in the anatomic make-up and to bear in mind the relation of injury to these foci of weakened resistance.

ROENTGENOLOGIC EXAMINATION OF THE NASAL ACCESSORY SINUSES IN INFANTS AND CHILDREN[1]

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IN the newborn, one sees well formed maxillary sinuses and a varying number of ethmoid cells. Seldom are the frontal and sphenoid sinuses materially developed at birth, or in early infancy. During infancy and early childhood, one sees the early development of the frontal sinuses into the vertical and horizontal plates of the frontal bone, from the ethmoid cells. The sphenoids are also noted then, developing first in the anterior part of the body of the sphenoid bone. One expects to see well developed frontal sinuses at the age of four or five years, and a well developed sphenoid at a slightly later age. The presence of an infection in the ethmoid cells and the maxillary sinuses may materially retard the development of the frontal and sphenoid sinuses. A certain percentage of adults have no frontal sinus development into the vertical plate, while others have only one frontal sinus. There are many variations in size, shape, and position of the sinuses, calling for individual interpretation in most instances.

In infants and children, there are technical difficulties in the roentgenologic examination of the sinuses which necessitate a modification in routine adult technic. Nowhere are patience and painstaking attention to detail more richly rewarded than in this type of roentgenography. The confidence of the child must be obtained if we are to obtain roentgenograms of maximum value. I need not stress the necessity, in many instances, of separating the child from its over-anxious parents before its confidence can be obtained and its fears allayed.

With infants, one must be content with

[1]Read by title before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30–Dec. 4, 1931.

roentgenograms in the postero-anterior and lateral projections. Rapid technic is possible with modern equipment, and, in most instances, satisfactory diagnostic roentgenograms can be obtained. If the head is held firmly by a nurse or assistant, one can often obtain a good roentgenogram even if the patient is crying. The x-ray switch must be controlled, and the exposure made by someone who can observe every motion of the infant, and who is thereby able to determine the proper time for making the exposure. It is very difficult to obtain satisfactory roentgenograms if the exposure is controlled from some distance behind a screen. I know that this is contrary to the usual principles of safety to the operator, but, if one wishes to obtain roentgenograms of good quality, the exposure must be controlled from a point close to the patient.

With children who are able to co-operate, and generally this includes children of three years or more, the adult technic can usually be followed in detail. Films are made without the use of the Bucky diaphragm. No special apparatus is used other than that found in any well equipped laboratory. A small cone, 11 inches in length, is used, with a 2.75-inch aperture. Cone pressure against the head is used for immobilization. This gives an average target-head distance of 16 inches. With all exposures, 1 mm. filter is used between the tube and the patient. The cone is carefully leveled before each exposure. If no special apparatus is used to hold the head, this detail is important. Cross-lines etched on the face of the cassette facilitate accurate centering of patient and cone on the film. The use of a small-aperture long cone, covering just the area to be examined, gives excellent detail and contrast. The head is placed directly on the cassette. I believe this is also important as it permits a minimum distance between the part to be examined and the film. Secondary radiation is prevented by the use of the small cone. Immobilization by cone pressure, or by a towel held firmly across the head by an assistant, is, in my hands, superior to other methods of holding the head.

Four, five, or six exposures are made of the sinuses. In adults, five exposures are routinely made on two 10×12 films. Two exposures are made on the first film, and three exposures on the second. On the upper half of the first film is made an exposure of the ethmoid and frontal sinuses, in the postero-anterior projection. The glabella is centered on this 6×10 inch area of film, the head resting on the forehead and nose. The cone is centered on the glabella with an average angle of 25 degrees toward the feet, and the cone brought firmly against the head over a small folded towel. On the lower half of the first film is made an exposure of the maxillary sinuses in the postero-anterior projection, with an average angle of 15 degrees toward the feet. The head rests on a small gauze roll beneath the glabella, and the chin. The gauze roll varies in thickness, being of such size that there is no distortion of the nose by pressure on the cassette.

On the upper half of the second film is made an exposure of the sinuses in the postero-anterior oblique projection, the central ray directed through the head at an average angle of 10 degrees toward the head of the patient, centering on the glabella. The head, resting on the forehead and nose (as in the first exposure on film No. 1), is held by a towel across its back, the cone being brought to within one inch of the surface. On the lower half of the second film are made two exposures, both in the lateral projection, at a distance of 32 inches. One view is centered on the sphenoid sinuses, the other on the ethmoid cells and including a lateral view of the frontals and maxillary sinuses. If the size of the mouth permits, a sixth view may be taken upon a mouth film, held in a special cassette of aluminum. This view is made through the top of the head, with the patient supine and the head resting

on a firm pillow. This view, on the mouth film, gives additional information concerning the sphenoid sinuses and some information concerning the ethmoids of the posterior group. Throughout this technic the only special piece of apparatus is the small mouth cassette. A small-aperture cone should be included in all standard apparatus. Children are especially apprehensive of any apparatus which clamps on the head for immobilization. Stereoscopy is not routinely or frequently employed.

The frequency of infections of the nasal accessory sinuses in adults is admitted by all rhinologists and roentgenologists: we have not accorded the same consideration to children. All children with chronic coughs should have an x-ray examination of the nasal accessory sinuses. Before tonsillectomy is resorted to, sinus examinations should be frequently made. In the presence of an otitis media and mastoiditis, it is often advisable to make a sinus x-ray examination, as the sinuses will not infrequently be found affected as well. The syndrome of broncho-sinusitis, recently reviewed by Wasson, is well known to you. Chronic sinus infections may be followed by chronic bronchitis and bronchiectasis. Parents seldom suspect the sinuses in the coughs of children, and all too frequently the child is given a course of tonics and cough mixtures without avail, when the cause of the cough lies in a sinus infection. Many of these patients are afebrile, and clinically appear in quite good health, aside from the distressing cough. Swimming, and especially diving, appear to lead quite frequently to sinus infections.

The common finding in sinusitis of infants and young children is a clouding of the ethmoid cells, and of one, or both, maxillary sinuses. It is probable that the ethmoid infection is primary. Thickening of the trabecular walls is noted in the chronic ethmoid infections. After clearing of the pus from the sinuses, one may note, particularly in the maxillary and sphenoid sinuses, thickening due to hyperplastic changes in the lining membrane. Osteomas may be noted in quite early childhood. Polyps are shown in the maxillary sinuses as circumscribed densities, uniform in shadow density, projecting into the antral cavity. Large polyps in the ethmoid cells may cause a broadening of the ethmoid cell area, and a thinning of the trabeculæ. Clearing of a sinus infection may be shown just as definitely by roentgenographic as by clinical examination. I do not believe that the use of opaque oils in sinus examination is either necessary, or advisable, in children. The rapid improvement noted in many of these children, under conservative treatment of the sinus infection, makes it highly advisable that we recognize early sinus infections in children, before the secondary chest pathology has become established. Early recognition and promptly instituted conservative treatment offer our best method of combating these chronic sinus and chest conditions.

CASE REPORTS

D. F., male, age 6 years, came with a complaint of difficulty in breathing through the nose. The right ear drum had been incised, and some tissue had been removed from the right side of the nose. Tonsillectomy and adenoidectomy had been performed two years before the present examination.

X-ray examination of sinuses, Jan. 10, 1930, showed: very small frontal sinuses; cloudy anterior ethmoid cells on both sides; clear posterior ethmoid cells; a very small sphenoid cell on each side anteriorly; a cloudy left maxillary sinus with granulations or polyp formation and a diminished antral space; thickened membrane (hyperplasia) of the right maxillary sinus.

R. S., female, age 7 years, complained of an obstructed nose which had been producing a discharge for the preceding three months. There was difficult breathing at

night, and, although there was no cough, the child cleared her throat frequently. There was an occasional rise of temperature and the patient was quite irritable. Tonsillectomy had been performed four years previous to the present examination. Clinically there was evidence of infection of the anterior sinuses.

X-ray examination of sinuses, Feb. 1, 1930, showed: small, shallow frontal on the right, with increased density; no demonstrable frontal on the left; bilateral cloudy anterior ethmoid cells; cloudy posterior ethmoid cells; small sphenoids in the anterior portion, of indeterminate density; cloudy maxillary sinuses with evidence of polyp formation.

M. B. W., Jr., age 7 years, was brought with the complaint that the left ear had begun to hurt two hours earlier. There was a slight sore throat. The child had had pain in the same ear two and one-half years previously, and the drum was incised at that time. Tonsils and adenoids had been removed twice.

X-ray examination, July 23, 1930, showed: small frontal sinuses, just beginning to extend into the anterior frontal plate; chronic thickening in both anterior and posterior ethmoid groups, with increased density; small sized sphenoids in the anterior portion; increased density of both maxillary sinuses, the right being more dense than the left, with thickened membranes bilaterally.

S. W., male, age 8 years. There was a complaint of frequent colds and enlarged tonsils. Vision was diminished 20/200 in each eye. There was a discharge from the left nostril and increased density of the left antrum on transillumination.

X-ray examination of sinuses, Nov. 22, 1930, showed: small, shallow left frontal; no right frontal development; left frontal cloudy; increased density of both anterior and posterior ethmoid groups: large sphenoid sinuses for a child of this age, with normal density of the sphenoids. The maxillary sinuses showed markedly increased density, being totally and equally cloudy on the two sides.

W. C., male, age 5 years. The complaint was of a discharge from both ears following an attack of pneumonia. Both ear drums had been incised and were draining. There was a discharge from the nose and clinical evidence of sinusitis.

X-ray examination of sinuses, Jan. 6, 1931, showed: very small frontal sinuses, not extended into the vertical plate of the frontal bone; hazy right anterior ethmoid cells, and totally cloudy left anterior ethmoid cells; cloudy posterior ethmoid cells; very small sphenoid sinuses, lying anteriorly; marked hyperplastic changes in the right maxillary sinus, chronic; total cloudiness of the left maxillary sinus. The chest, the same date, showed chronic mediastinal and tracheobronchial lymphadenitis.

T. D., male, age 6 years, came with a complaint of acute otitis media.

X-ray examination, March 13, 1931, showed: no demonstrable frontal sinus development; small size sphenoids; increased density in both anterior and posterior ethmoid groups and in both maxillary sinuses. The appearance suggested a sinus infection of long standing.

J. M., male, age 5 years, was brought with a history of having been sick with frequent head colds for three months preceding the present examination. Nasal discharge had been profuse, and there had been difficulty in breathing through the nose. There was no earache. The tonsils were chronically infected.

X-ray examination of the sinuses, Apr. 7, 1931, showed: cloudiness throughout all of the nasal accessory sinuses; frontal sinuses small, with the right larger than the left; small sphenoid sinuses; generalized sinus infection.

G. H., female, age 8 years. The child did not talk plainly. She had been recently ex-

amined at school and was told that the right ear was slightly deaf. There was a productive cough, and a discharge from the nose, with much yellowish discharge from the right nostril. There was clinical evidence of a probable maxillary sinusitis.

X-ray examination of the sinuses, Oct. 24, 1930, showed: no development of the frontal sinuses; cloudiness of the anterior ethmoid cells on both sides; total cloudiness of the left antrum; increased peripheral density of the right antrum, with a small central cavity, and evidence of granulations or polyp formation.

H. H., male, age 7 years, 6 months. There had been intermittent cough for the preceding three years. The child had had treatment for sinus infection at various times during this period.

Examination of the sinuses, May 3, 1930, showed: normal frontal sinus development for a child of this age; cloudiness of the right anterior ethmoid cells; total cloudiness of the right maxillary sinus; increased peripheral density, with hyperplasia of the membrane, left maxillary sinus.

Examination on Jan. 27, 1931, showed: both frontal sinuses to be well developed, but both showing increased density; increased density of both anterior and posterior ethmoid groups, with trabecular thickening; sphenoid sinuses of small size, but with increased relative density; increased density of both maxillary sinuses, with demonstrable hyperplasia of the membrane in both.

M. C., female, age 17 years. Examination elicited heart murmur, chronically infected tonsils, and albumin in the urine.

X-ray examination of the sinuses, Jan. 3, 1931, showed: normal sinus development throughout; normal trabecular definition; normal density.

A. P., female, age 16 years. There was clinical evidence of an acute sinus infection.

X-ray examination, March 8, 1931, showed: absence of frontal sinuses; large supra-orbital cell on the left side, ethmoidal; clear right anterior ethmoid cells; left anterior ethmoid cells slightly increased in density, with thickening of the trabeculæ; posterior ethmoid cells normally clear; sphenoids small, normal in density. The maxillary sinuses presented hyperplasia of the lining membrane, with a slight increase in general antral density, the left antrum being slightly greater in density than the right.

SUMMARY AND CONCLUSIONS

While it is true that there are technical difficulties to be overcome in roentgenography of the nasal sinuses in infants and young children, patience and attention to detail are rewarded here, as elsewhere, in proportion to the care exercised. Satisfactory diagnostic roentgenograms are obtained in most instances, and quite accurate analyses of sinus pathology are possible. The roentgenologic study of the nasal accessory sinuses offers a valuable aid to the clinician in his appreciation of the location and degree of sinus infection present, and is a guide to treatment.

Examination of the nasal accessory sinuses should be routinely made of all children with chronic cough, chronic tonsillitis, persistent nasal discharge, otitis media, and mastoiditis. Early recognition of sinus pathology in children, with promptly instituted conservative methods of clinical treatment, offers our best means of preventing the distressing cough, chronic bronchitis, and bronchiectasis which may follow. It is the duty of the roentgenologist to acquaint the medical profession more generally with the frequency of sinus infections in children, and to emphasize the value of roentgenologic examination in the recognition of them.

THE VALUE OF A MULTI-PERFORATED SCREEN IN DEEP X-RAY THERAPY[1]

A PRELIMINARY REPORT ON A NEW METHOD OF DELIVERING MULTIPLE ERYTHEMA DOSES WITHOUT PERMANENT INJURY TO THE SKIN

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THE deleterious effect on the skin of delivering large doses of x-rays to an underlying tumor has been frequently the main deterrent to the successful treatment of malignancies. The method at present proposed to circumvent this difficulty is based on the fact, well known to all x-ray therapists, that when small areas of skin are treated, as in epitheliomas or verrucæ, large doses of radiation (from four to six erythema doses to an area 1 cm. in diameter) can be given with safety. Apparently the presence of adjoining normal tissue protects the small radiated area from vesiculation and ulceration.

Taking advantage of this observation, the author began a study of the effects of radiating deep structures through numerous small areas simultaneously (say, from 200 to 400 areas per large portal). The radiation is delivered through a multi-perforator, a sheet of lead from 1.5 mm. to 2 mm. in thickness, with uniform perforations regularly spaced and comprising a definite percentage of the total square area. This perforated lead sheet is placed on the skin. The perforations obviously can be of different sizes and shapes, exposing more or less of the skin to direct radiation, and leaving greater or smaller isthmuses of normal skin, protected by lead, to act as centers of healing in case the radiation is of such magnitude as to cause ulceration of the radiated skin.

Some of the designs tried out were as follows:

1. Strips of lead 1 cm. wide and 20 cm. long, 10 in number, fastened to a 20×20 cm. piece of celluloid, 1 cm. space between the strips of lead. This design was found not to be servicable on account of insufficient protection to the skin.

2. Lead squares, 1×1 cm. each, arranged in a checkerboard fashion, fastened to a piece of celluloid, alternating the lead squares with equal spaces. This method was found to be unserviceable on account of the difficulties of proper construction and insufficiency of protection.

3. A latticework effect in a sheet of lead, obtained by punching out squares, lozenge shapes, or hexagonal perforations, leaving an area of one-half the original area. This method has been found to be unserviceable when (1) the perforations are of 1 sq. cm. area, on account of too narrow, uniform isthmuses of protected skin, resulting in insufficient protection; (2) when perforations are of less than 0.5 sq. cm. area, the angles interfering with delivery of maximum radiation, especially if the perforator has to be bent over the treated area, and forms an angle with a perpendicular to the central ray.

4. Round or oval perforations of varying sizes from 2 to 8 mm. in diameter, the perforated area comprising two-thirds, one-half, or one-fourth of the total area. This type is not difficult of construction and offers the maximum skin protection, especially if the perforations are less than 8 mm. in diameter. The reason for the greatest protection is found in the fact that the spaces between the perforations have varying diameters, narrowest in the axis of the cross diameter of the perforator, and largest in the axis of the oblique diameter of the per-

[1]Approved for publication by the Surgeon-General, U. S. Public Health Service.

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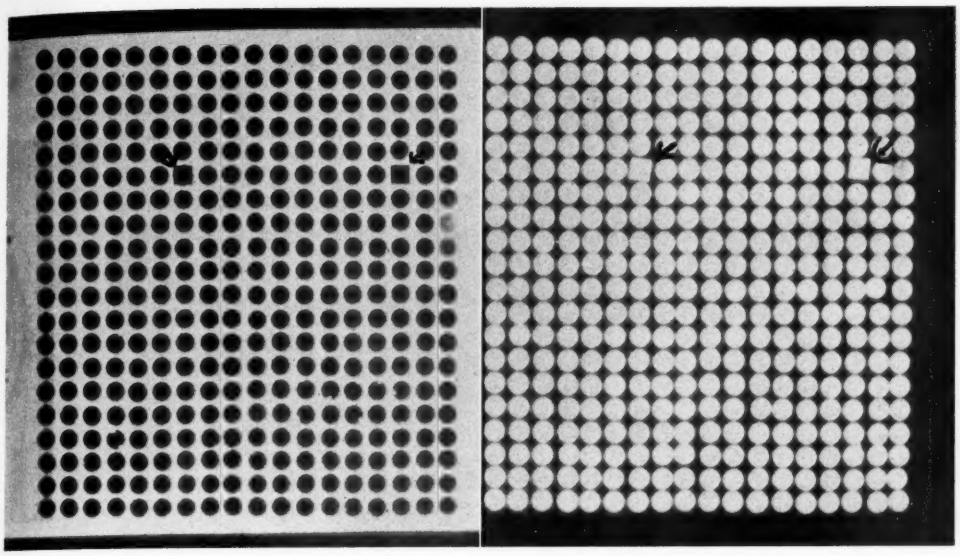


Fig. 1. On the left is a photograph of the lead perforator of 0.5 sq. cm. perforation to each sq. cm. of lead. Note the two eccentric square perforations, also the wide margin of lead on the left. These are used for replacement of the perforator in the identical position on the skin when the entire dose is not given in one sitting. On the right is a photograph of the reciprocal perforator made by placing the lead cutouts in the perforator, or a paper pattern of the lead perforator. A solution of acetocellulose or collodion or glue is then poured over the pieces of lead, after which washed-off film or paper is placed over it and allowed to dry for a few days. When thoroughly dried, the lead cutouts are gently pushed out of the perforator, without displacement, in order to insure a perfect reciprocal. The other side is now fastened to another piece of celluloid and is ready for use.

forator, furnishing sufficient nucleus of healthy skin for replacement of the treated area.

After four months' trial with these perforators, the one in Group 4, with circular openings, comprising one-half the total square area, was found most satisfactory for continued study.

We may ask at this point: Must we deliver a total of two, three, or four erythema doses at one sitting, or may we divide the dosage and still give the skin the necessary protection of the perforator?

By the following method division is made possible, if so desired. The perforator (Fig. 1) is about 20 cm. square, and is fastened to the skin with adhesive. At two eccentric points the holes are of slightly different shape. These variations allow the marking of the skin with mercurochrome or any other dye non-opaque to the x-ray, in order that the perforator may be replaced over exactly the same area at the next session of the treatment. This enables the delivery of the total dose in more than one sitting. Sometimes a paraffin cast must be made and placed against a movable part, such as the neck or arm, in order to assure the same position of flexion of the parts at subsequent sessions.

The efficacy of this method of radiation was investigated along three different lines: (I) with water and paraffin phantoms, to determine experimentally just what percentage of the delivered radiation a body placed at different depths does receive through the perforator; (II) the difference in effect of a given dose without the perforator and an equivalent dose with it, tried experimentally on animals, and (III) the clinical application.

Taking up these studies in the order

enumerated, the writer arrived at the following results.

I

The theoretical part of this investigation concerning the actual dosage received at varying depths of phantom, with and without the perforator, is charted in Table I. A careful study shows that with the perforations comprising one-half of the square area, the radiation received by a body about 5 cm. under the perforator, is almost exactly half the radiation received without the perforator, as is to be expected theoretically. In cases in which the ionization chamber is very close to the perforator, however, the skin often receives less than half the total radiation, because the chamber is so small (the writer used the Wolf chamber) that it often fails to cover a characteristic square area with one-half square area of perforation in it. With the larger (Duane) chamber, this difficulty is entirely obviated. Conversely, as the ionometer depth reaches above 8 cm., more than the theoretical half of the radiation comes through, especially with the higher voltages. This may be attributed to the slight additional radiation coming from the higher voltages, which penetrates partially through the lead of the perforator, if it is less than 2 millimeters thick.

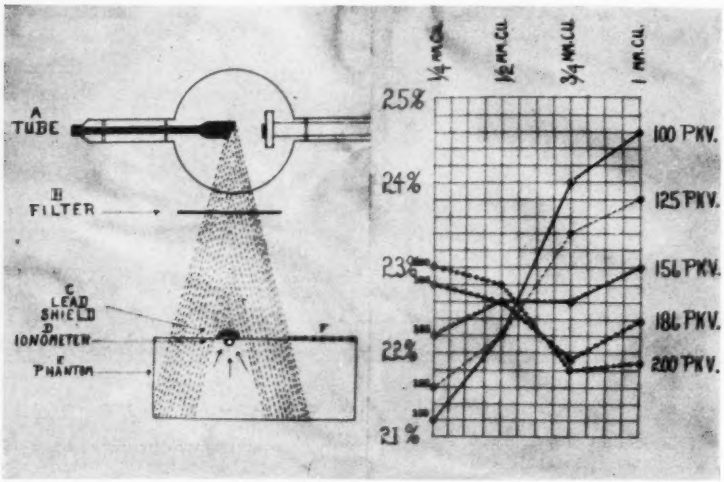


Fig. 2. Determination of back-scattering: On the left is an arrangement of *A*, tube; *B*, filter; *C*, ¼ in. lead cover on ionometer to shield it from direct radiation; *D*, ionometer; *E*, phantom; *F*, cross-section of perforator to show how the study of the back-scattering with the shielded ionometer simulates the condition of the skin under the lead isthmuses of the perforator.

The graph on the right indicates the range of back-scattering from 21 to 24.5 per cent. Note that the greatest back-scattering is present in the highest filtration with the lowest voltage here tested.

Of great importance is the consideration that the skin receives not only the radiation delivered directly to it, but also the secondary reflected rays of back-scattering. Table II and Figure 2 show that fully from 21 to 24.5 per cent of the total radiation (depending upon the voltage and filter used) will be scattered back to the skin after it has penetrated to the deeper structures. This means that even in cases in which the skin is protected by the isthmuses of lead from direct radiation, it will receive by back-scattering almost a full erythema dose for every four erythema doses delivered through the perforator. This would tend to

TABLE I. DETERMINATION OF THE QUANTITY OF RADIATION AT DIFFERENT DEPTH OF PHANTOM WITH THE PERFORATOR

Constants: 4 ma.; 70 cm. target-ionometer distance; filter, 1 mm. Al, 2 cm. wood.

		0.25 mm. Cu			0.5 mm. Cu			0.75 mm. Cu			1 mm. Cu		
125 P.K.V.	Depth in phantom (cm.)	I	II	III %	I	II	III %	I	II	III %	I	II	III %
	1	4.8	59.3	+1.2	3.1	59.	+1.7	2.1	58.7	+2.3	1.8	59.3	+1.7
	2	4.1	59.	+1.7	3.	59.	+1.7	2.	59.7	+0.6	1.7	58.3	+2.9
	3	3.8	60.3	—0.6	2.7	59.7	+0.6	2.	59.	+1.7	1.6	58.7	+2.3
	4	3.3	59.7	+0.6	2.1	58.7	+2.3	1.8	59.7	+0.6	1.3	59.3	+1.2
	5	2.7	58.7	+2.3	2.	59.3	+1.2	1.5	59.3	+1.2	1.2	59.	+1.7
	6	2.4	59.7	+0.6	1.6	60.	+0.	1.3	59.	+1.7	1.	59.	+1.7
	7	2.3	59.	+1.7	1.5	59.7	+0.6	1.1	59.7	+0.6	0.9	58.3	+2.9
	8	2.1	59.7	+0.6	1.2	59.	+1.7	1.	58.3	+2.9	0.7	59.7	+0.6
	9	2.	59.3	+1.2	1.1	59.7	+0.6	0.8	59.7	+0.6	0.6	59.	+1.7
	10	1.7	58.	+3.5	0.9	59.3	+1.2	0.6	59.3	+1.2	0.5	59.7	+0.6
155 P.K.V.	1	8.6	59.7	+0.6	5.9	59.3	+1.2	4.3	59.	+1.7	3.8	59.6	+0.6
	2	7.2	59.	+1.7	5.5	59.	+1.7	3.9	59.3	+1.2	3.4	60.3	—1.7
	3	7.	59.	+1.7	5.1	59.3	+1.2	3.8	59.3	+1.2	3.3	59.	+1.7
	4	6.5	60.	+0.	4.8	59.3	+1.2	3.4	60.	+0.	3.1	58.6	+2.3
	5	6.2	59.	+1.7	4.4	59.7	+0.6	3.2	59.7	+0.6	3.	59.6	+0.6
	6	5.7	58.7	+2.3	4.1	60.	+0.	3.	59.3	+1.2	2.9	59.	+1.7
	7	5.2	59.3	+1.2	3.6	58.7	+2.3	2.8	59.	+1.7	2.7	59.3	+1.2
	8	4.7	58.7	+2.3	3.4	59.	+1.7	2.6	58.7	+2.3	2.3	59.6	+0.6
	9	4.3	59.3	+1.2	3.3	59.	+1.7	2.3	58.7	+2.3	2.1	59.	+1.7
	10	3.9	58.7	+2.3	3.	59.7	+0.6	2.1	59.3	+1.2	1.8	59.3	+1.2
186 P.K.V.	1	10.4	61.	—1.7	9.	61.	—1.7	7.	60.	+0.	5.2	59.	+1.7
	2	9.8	60.3	—0.6	7.9	59.7	+0.6	6.	60.	+0.	4.4	58.7	+2.3
	3	8.8	59.7	+0.6	7.	58.7	+2.3	5.7	58.	+3.4	4.1	58.	+3.5
	4	8.	59.7	+0.6	5.9	59.	+1.7	4.8	58.	+3.5	3.6	58.3	+2.9
	5	7.3	59.	+1.7	5.	58.7	+2.3	4.	58.	+3.5	3.3	58.	+3.5
	6	6.	58.	+3.5	4.3	58.7	+2.3	3.8	58.3	+2.9	3.1	58.	+3.5
	7	5.7	58.3	+2.9	4.2	59.3	+1.2	3.6	59.	+1.7	3.	58.3	+2.9
	8	5.4	59.	+1.7	4.	59.3	+1.2	3.4	58.3	+2.9	2.6	58.	+3.5
	9	4.7	10.	+0.	3.8	59.	+1.7	3.	58.3	+2.9	2.2	58.	+3.5
	10	4.	59.	+1.7	3.1	59.7	+0.6	2.5	59.7	+0.6	1.9	59.7	+0.6
200 P.K.V.	1	12.3	60.3	—0.6	10.4	60.	+0.	7.8	59.7	+0.6	6.5	60.	+0.
	2	12.	60.7	—1.2	9.	60.	+0.	7.	58.	+3.3	6.	58.3	+2.8
	3	11.1	58.7	+2.2	8.9	59.	+1.7	6.7	59.	+1.7	5.6	58.	+3.3
	4	10.8	58.7	+2.2	8.	59.3	+1.2	5.9	59.3	+1.2	4.5	58.3	+2.8
	5	7.6	59.3	+1.2	6.1	59.	+1.7	5.2	59.	+1.7	4.1	59.	+1.7
	6	7.4	58.7	+2.2	5.8	59.	+1.7	5.1	58.7	+2.2	4.	58.	+3.3
	7	7.2	58.7	+2.2	5.6	58.3	+2.8	4.8	58.	+3.3	3.9	58.7	+2.2
	8	6.9	59.7	+0.6	5.1	58.3	+2.8	4.	58.3	+2.8	3.4	58.3	+2.8
	9	5.9	59.7	+0.6	4.4	59.3	+1.2	3.8	58.	+3.3	3.1	58.3	+2.8
	10	5.7	59.	+1.7	4.	60.	+0.	3.3	59.3	+1.2	2.6	60.	+0.

Each ionometric reading here recorded is the mean of four readings, taken at various hours of the day.

Column I represents the quantity of ionization in 30 seconds at the depth indicated.

Column II represents the time required to get same ionometric reading with the perforator of 0.5 sq. cm. perforation to each sq. cm. of lead interposed.

Column III represents the percentage of radiation above or below 50, transmitted through the perforator, calculated from Column II.

Note that at no single reading is the variation over 3.5 per cent; within range of experimental error.

set the safe limit of radiation through the perforator at four erythema doses.

An equally important consideration is the homogeneity of the radiation. Since the radiation delivered comes in streamers through the holes in the perforator, it is evidently not homogeneous, except at great depths. This lack of homogeneity may even be a desirable feature, and it is to be investigated further from just that point of view. However, if homogeneity is desired, it may be obtained by changing the position of the tube after half the radiation has been delivered. Thus, with a skin-target distance of 60 cm., perforations 1 cm. apart, *i.e.*, 0.5 cm. from center to periphery, and the lesion 10 cm. from the surface, an almost homogeneous radiation in one plane is obtained if the tube is moved 3 cm. and half the dose is delivered from each of the two positions (Fig. 3). For greater homogeneity yet, one-fourth of the dose may be delivered from each of four positions, 3 cm. apart, as indicated in Figure 3. If the lesion happens

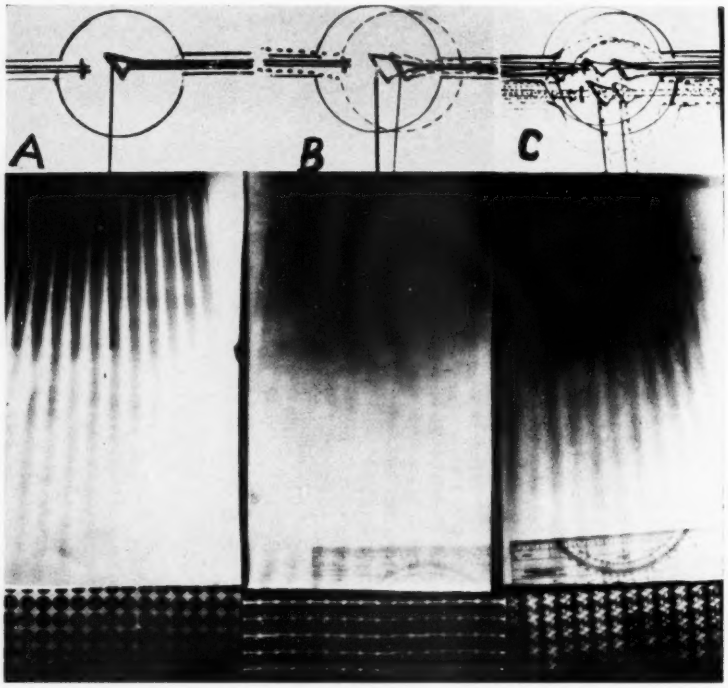


Fig. 3. Shows how the shifting of the position of the tube converts the streamer radiation as seen in *A* to almost homogeneous radiation in one plane, as seen in *B*, and to almost homogeneous radiation in all planes (at predetermined depth), as seen in *C*. The upper part of the figure shows the positions of the tube for the exposures recorded on the films below. The middle portions represent the appearance of the streamers in the vertical plane. The bottom of this figure shows the appearance of the corresponding streamers in the horizontal plane at 10 cm. from the surface of the phantom under the perforator. In *A*, the entire radiation was delivered with the tube in one position. In *B*, half of the radiation was delivered with the tube in one position, the other half after shifting the tube 3 cm. in one direction. In *C*, one-quarter of the radiation was delivered from each of the four positions of the tube.

TABLE II. DETERMINATION OF BACK-SCATTERING IN PERCENTAGE OF TOTAL RADIATION

Filters:	0.25 mm. Cu			0.5 mm. Cu			0.75 mm. Cu			1 mm. Cu		
	I	II		I	II		I	II		I	II	
Kilovolts	30 sec.	Minutes	Seconds	30 sec.	Minutes	Seconds	30 sec.	Minutes	Seconds	30 sec.	Minutes	Seconds
	3.6	2	22	1.9	2	15	1.1	2	5	0.8	2	3
100	3.5	2	20	1.9	2	15	1.1	2	5	0.8	2	3
K.V.	3.5	2	20	1.9	2	15	1.1	2	5	0.8	2	2
	3.5	2	21	1.9	2	15	1.1	2	5	0.8	2	2
Percentage of radiation	21.2%			22.2%			24%			24.5%		
	6.2	2	20	3.8	2	15	2.5	2	7	1.9	2	6
125	6.2	2	17	3.8	2	15	2.4	2	8	1.9	2	7
K.V.	6.1	2	17	3.8	2	15	2.4	2	8	1.9	2	7
	6.1	2	17	3.8	2	15	2.5	2	7	1.9	2	6
Percentage of radiation	21.8%			22.2%			23.5%			23.8%		
	9.9	2	15	6.7	2	12	5.2	2	13	4.3	2	10
156	10.	2	15	6.7	2	12	5.3	2	12	4.3	2	10
K.V.	9.9	2	15	6.8	2	12	5.3	2	12	4.3	2	10
	10.	2	15	6.7	2	12	5.2	2	12	4.3	2	10
Percentage of radiation	22.2%			22.6%			22.6%			23%		
	14.1	2	12	10.4	2	12	8.	2	17	6.2	2	12
186	14.	2	11	10.3	2	12	8.1	2	16	6.2	2	14
K.V.	14.	2	11	10.4	2	10	8.	2	17	6.2	2	14
	14.1	2	12	10.3	2	14	8.	2	18	6.2	2	14
Percentage of radiation	22.8%			22.6%			21.9%			22.4%		
	16.4	2	10	11.7	2	10	8.7	2	15	7.5	2	16
200	16.2	2	10	11.8	2	12	8.8	2	17	7.5	2	16
K.V.	16.6	2	10	11.7	2	12	8.8	2	17	7.5	2	16
	16.4	2	10	11.8	2	10	8.7	2	17	7.5	2	15
Percentage of radiation	23%			22.8%			21.8%			22.1%		

Constant throughout the experiment: Target-ionometer distance, 60 cm.; 4 ma.; filter, 1 mm. Al, 2 cm. wood. Variants: Voltage and Cu filter. Phantom: paraffin (30 cm. block); also basin of water (20 cm. deep). Arrangement of experiment: See Figure 2.

Column I represents the ionometric reading in 30 seconds from the radiation and filter above indicated. Column II, the time in minutes and seconds to get the same ionometric reading with the ionometer shielded by lead from all direct radiation. The column marked "Percentage of radiation" shows the total percentage of back-scattering. The findings are graphed in Figure 2.

to be less than 10 cm. from the skin surface, the tube is moved more than 3 cm., as simple arithmetic proportion indicates.

II

The biological effect of radiation through the perforator was tried on ova, on white mice and on rabbits. In the ova, the findings were not critical. In the case of mice, the animals were treated *in toto*, being considered as tumor implants. The mice were placed at depths of 5, 7, and 10 cm. from the surface of a phantom of paraffin (Table III). The results show that whereas three erythema doses delivered without the perforator killed the majority in from 8 to 20 days, the equivalent ionometric radiation through the perforator killed the majority of those mice in less than 8 days. The perforator radiation apparently has effective "destruction potency."

In the treatment of the rabbits, localized areas of skin were exposed to radiation rather than the whole animal, approximating more closely the clinical use of the method. The theoretical part of the investigation had established the fact that the half square area perforator delivered half

TABLE III

Number of animals	3	3	3	6	6	6	4	4	4	4	4	4
P.K.V.	125			186			186			186		
Ma.	4			4			4			4		
Distance from target to mouse	30 cm.			40 cm.			60 cm.			60 cm.		
Distance from target to phantom							50	50	50	50	50	50
Filters in mm. aluminum	0			1	1	1	1	1	1	1	1	1
Filters in mm. copper	0			0			¼	¼	¼	¼	¼	¼
Time in sec., min., or hours	5m.	10m.	20m.	15m.	30m.	30m.	2 hr.	2.5 hr.	3 hr.	4 hr.	5 hr.	6 hr.
Ionization in r units at position of animal	3.6 r per sec.			58 r per min.			16 r per min.			16 r per min.		
Total r units delivered to animal	1080	2160	**2160**	870	1740	**870**	1920	2400	2880	**1920**	**2400**	**2 80**
Phantom thickness above	0	0	0	0	0	0	7cm.	7cm.	7cm.	7cm.	7cm.	7cm.
Phantom thickness under	0	0	0	0	0	0	20cm.	20cm.	20cm.	20cm.	20cm.	20cm.
Exodus within 1 hour			2									
Exodus within 24 hours		2	1		2				1			
Exodus within 8 days						1		1	2	1	4	4
Exodus within 20 days	2	1		2	4	1	1	3	1	3		
No exodus in 1 month	1			4		4	3					

Table III. The numbers in italics represent animals treated with the perforator. Note that in the last three columns on the right, most of the animals died before the eighth day. In the next three columns although the equivalent radiation has been given without the perforator, the majority of the animals treated died after eight days.

the total radiation to the underlying tissues. If the limit of safe radiation without the perforator is now determined, and we can give with safety more than twice that dose with the perforator, its usefulness is clearly demonstrated. This is exactly what occurred with the rabbits. The dose necessary to cause epilation within 15 days on one side of the buttocks and back of four rabbits was determined. Three times this dose delivered to the other side of the back and buttocks through the perforator caused only slight epilation after 21 days. In four other rabbits the lower back and buttocks were epilated by chemicals, and the minimum dose that causes slight ulceration and crusting of the skin was determined. Three times this dose delivered to the other side through the perforator caused no ulceration in any of the animals, and only faint crusting in one (Fig. 4).

Fig. 4. On the right side a dose sufficient to cause crusting was given. On the left, three times this dose was delivered through the perforator with even less permanent damage to the skin.

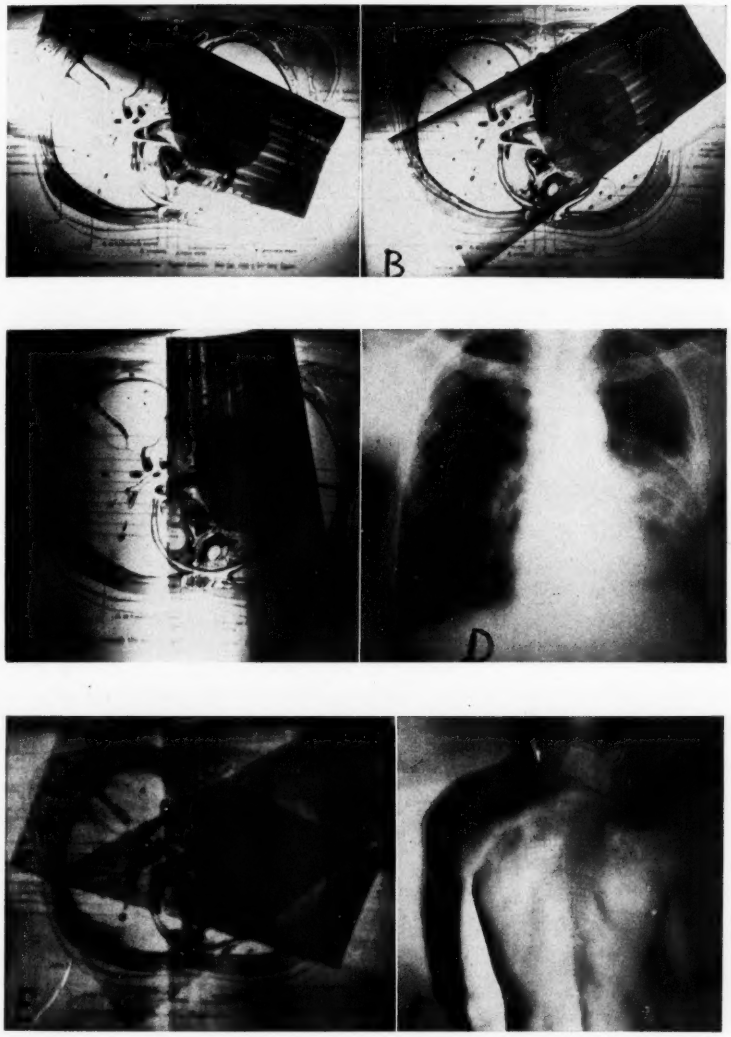
III

The clinical investigation of this method has been quite limited, of course, to date. In normal volunteers, an erythema dose was delivered to the shaved thigh, and three erythema doses were given through the perforator to a corresponding area. There was no vesiculation or ulceration in either area. A few resistant skin lesions were treated with the 0.25 sq. cm. perforator, giving three erythema doses with no vesiculation. However, the marks of the perforations lasted 8 months.

In working out the technic of the application of this method in the actual treatment

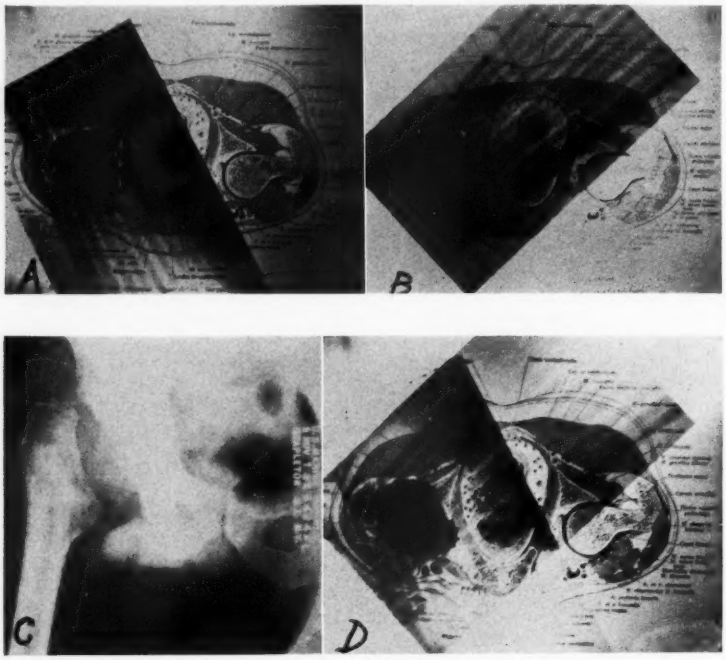
of tumors, due cognizance was taken of the site of exit of the rays as well as the site of entry on the skin. When looking for all possible skin fields of entrance for the rays, the site of exit of previous radiation must be assiduously avoided. The exact technic, as developed to the present, is as follows:

The lesion, in its exact size, shape, and



Figs. 5-*A* to 5-*F*. These show the arrangements of the portals of treatment in a case of neoplasm of the left side of the chest *D*, with metastasis in the cervical spine. The tumor is plotted on a topographical cross-section of the chest. *A* shows the plotting of one of the suitable streamers of size sufficient to cover the tumor by a small margin, the streamer directed from the left axilla anterior to the right axilla posterior. *B*, directing the streamer from the left axilla posterior to the right axilla anterior. *C*, from the left back to the left front. Note that in *E* all streamers cross in the region of the tumor, but neither the entrance nor the exit rays cross at any skin surface. *F* shows the appearance of the skin two weeks after treatment with three erythema doses through the perforator.

situation, is charted on one of the topographical cross-section films of the body at that segmental level, and the distance from the various skin surfaces is marked. The fields of entry and the radiation angles are mapped out with the aid of a model "streamer" that represents the general direction and spread of the characteristic radiation, after it has passed through the perforator. Care is taken that the streamer lines do not meet on the entrance and exit of the rays at the skin surfaces, but meet only in the region of the tumor. The dosages at the depth of the tumor are computed from the dosage charts; then the necessary quantity of radiation is delivered through these portals as outlined by the entrance and exit streamers (Fig. 5).



Figs. 6-*A* to 6-*D*. Show the plan of radiation applied to an osteogenic sarcoma of the femur *(C)* in a man of 42, with metastasis to the lungs. In *A* the tumor is plotted on a topographical cross-section through the head of the femur, with suitable streamer directed from the gluteal region to the pubes, from the anterior external to the posterior central. The streamers cross in the tumor area as seen in *D*. In both their entry and exit the streamers avoid each other and are, therefore, satisfactory. However, no room has been left for a third streamer without its crossing in the skin. In such a case the radiologist should plan the maximum radiation through two portals only.

Sometimes one portal is directed upward toward the head, and the portal from the opposite surface of the body is directed toward the feet, in order to avoid crossing of the entrance and exit rays of the opposite surfaces of the body treated. Sometimes the radiation is directed obliquely from one surface to the right side and from the other surface to the left, and sometimes an entire portal may be avoided to diminish the effect from the exit of the rays (Fig. 6).

It might be mentioned, finally, that after all suitable areas of skin have been radiated through the perforators, one may still attempt to re-deliver (after a 4-week interval of treatment to the same area) several erythema doses through the isthmuses of normal skin formerly left protected, by us-

ing a reciprocally patterned perforator this second time (Fig. 1). The attempt to do this has been entirely successful and encouraging. The advantage of this form of treatment lies in the fact that while the skin over a portal is recuperating from the radiation, the tumor mass is meanwhile given radiation through a second and a third portal, and by the end of four weeks, the first portal is again ready for a treatment through the formerly protected area.

In the treatment, then, of clinical material, we have to bear in mind the following:

The field of exit of rays must not fall over the field of entrance from the opposite side.

The size of the area treated should be as small as possible, and although amply covering the entire tumor, should do so by a narrow margin only.

At least four weeks should pass after the use of the primary perforator before the reciprocal perforator is used.

At the present moment the practical application of this method is awaiting more extensive investigation as to (1) the limit of width of the perforator isthmuses; (2) the optimum size and the shape of the perforations; (3) the maximum number of perforated areas with optimum skin protection in skins of various individuals.

SUMMARY

Radiation through a lead sheet, with circular perforations, comprising half the total square area, delivers half the total dose to the underlying tissues. Similarly, if the perforated area comprises two-thirds of the square area, it delivers two-thirds of the total applied radiation. Since the remote effect upon the skin of both rabbits and man is the same when three or four times as much radiation is delivered through the perforator as without it, the underlying tissue actually receives one and a half to two times as much radiation with the perforator as without it.

Because of the increased dosage obtainable without permanent injury to the skin, the author proposes this method for the treatment of selected cases of malignancy.

THE EFFECT OF X-RAYS ON BACTERIA IN MEDIA OF HIGH SPECIFIC GRAVITY

PRELIMINARY REPORT[1]

By WAYNE A. JOHNSTON, M.D., DUBUQUE, IOWA

THE older radiologists undoubtedly have noted improvement in some cases following the injection of Beck's paste into a sinus for radiographic purposes, this being especially true in the years between 1908 and 1915 (1, 2). Less improvement has been noted since the latter date. Coinciding with this transition in the results and, therefore, the use of Beck's paste, there was also a transition going on in our x-ray technic and equipment. With the old gas tube, plates, and no screens, we had to be on constant guard against burning a patient in our effort to secure satisfactory roentgenograms. In other words, at the same time we were making roentgenograms we were actually treating the patient. With the development of the hot cathode tube, films with double emulsion, and intensifying screens, the length of our exposure was very markedly reduced. It is my contention that it was because of this shortened time of exposure that less satisfactory therapeutic results were obtained with Beck's paste. To

[1]Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30–Dec. 4, 1931.

verify this opinion I undertook the work which follows.

Pure and fresh cultures of *Staphylococcus aureus,* obtained from boils, were grown on agar. A platinum loop of these bacteria was mixed with 1 oz. Beck's paste. A similar loop of the same bacteria was mixed with 1 oz. physiologic salt solution, and the two mixtures were simultaneously exposed to x-rays, the factors being 110 K.V., 5 ma., 0 filter, and 10 in. focal distance. Single loops of the suspension and of the paste were transferred to agar plates at intervals of 5, 10, 30, and 60 minutes. At the end of 5 minutes, it was found that there was some inhibition of bacterial growth in the paste, which increased with the various time intervals, up to 60 minutes, when there was very marked inhibition. There was no inhibition in the growth of bacteria transferred from the suspension even after 60 minutes of exposure. This finding is in agreement with a very excellent résumé of the literature by Klövekorn (3). The exposure was repeated nine times, each time with a fresh culture of *Staphylococcus* from a different source. The same result was always obtained. Control cultures, taken from

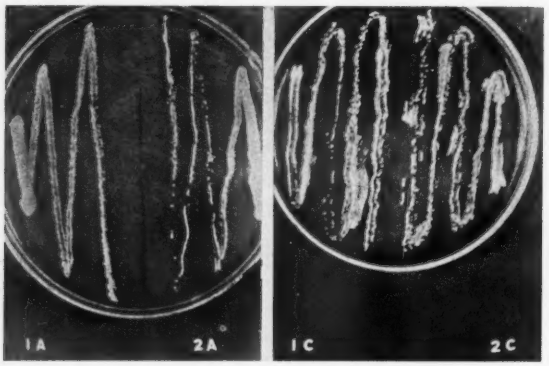


Fig. 1 *(first plate).* Beck's paste. 1-*A,* 1-*C,* Staphylococci suspended in normal salt solution. 2-*A,* 2-*C,* Staphylococci suspended in normal salt solution after exposure to x-rays for one hour. X-ray factors: 110 K.V., 5 ma., 0 filter, 10-in. distance.

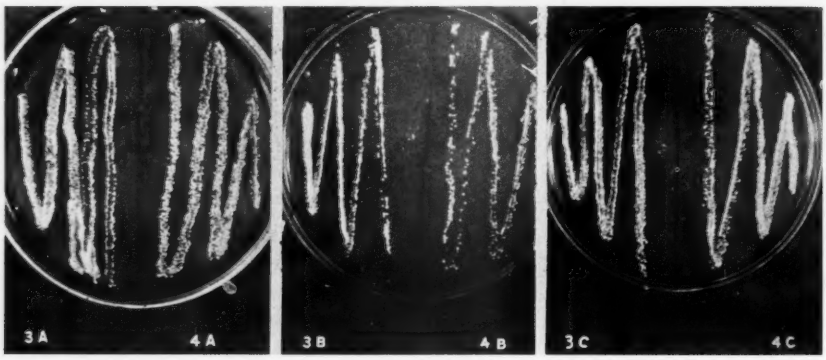


Fig. 1 *(second plate).* Beck's paste. 3-*A,* 3-*B,* 3-*C,* Staphylococci mixed with Beck's paste—control. 4-*A,* 4-*B,* 4-*C,* Staphylococci mixed with Beck's paste and treated with x-rays for five minutes. Same x-ray factors.

the paste similarly mixed with bacteria and untreated, showed no inhibition, even after several hours' contact.

controlling factor, I repeated the same experiment with lipiodol, in which iodine is the dominant factor. I found that bacteria

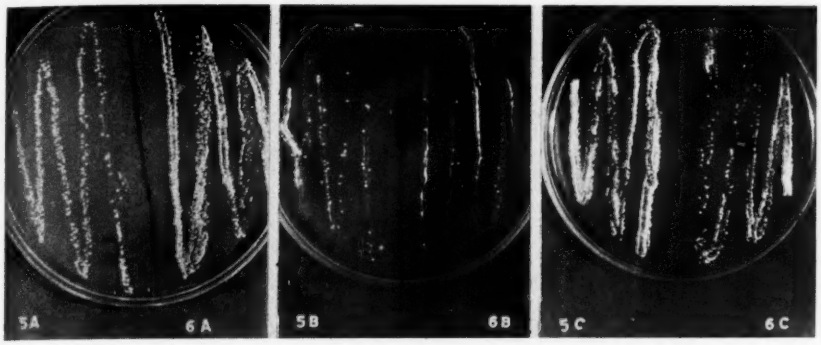


Fig. 1 *(third plate)*. Beck's paste. 5-*A*, 5-*B*, 5-*C*, Same staphylococci as shown in previous plates, mixed with Beck's paste and treated with x-rays for ten minutes. 6-*A*, 6-*B*, 6-*C*, Same mixture, treated for thirty minutes. Same x-ray factors.

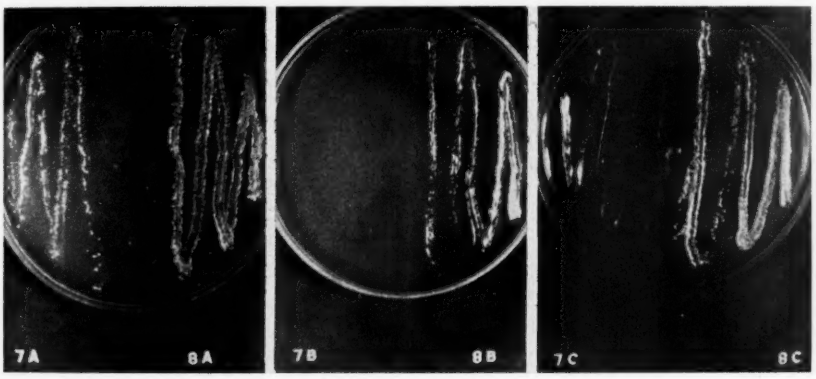


Fig. 1 *(fourth plate)*. Beck's paste. 7-*A*, 7-*B*, 7-*C*, Same mixture as shown in previous plate, treated for sixty minutes. 8-*A*, 8-*B*, 8-*C*, Same mixture as shown in previous plate, untreated for sixty minutes—control. Same x-ray factors.

My only means of explaining this result is that the presence of a heavy metal, bismuth, in the paste produced sufficient secondary x-rays to intensify the action of the rays, causing a deleterious action on the bacteria. Perhaps the explanation lies in the fact that these secondary rays, being much softer, have a more effective action against the bacteria. There is considerable work being done now on the effect of the extreme soft ray on bacteria.

In order to substantiate my conclusion that the presence of a heavy metal was the

are very little, if any, affected by standing in lipiodol, but that, when the staphylococci-lipiodol mixture was exposed to x-rays, the degree of inhibition seemed to progress at almost the same rate as was found in Beck's paste.

A similar experiment was performed with bacteria suspended in a solution of barium sulphate, but no inhibition was found. This experiment was performed only once: I expect to repeat it later. The atomic weight of barium is 137.37 as compared to bismuth, 208, and iodine, 126.92. Either

there must be some mistake in this experiment, or the ratio of the barium present was not great enough, or it is not the high atomic weight of the metal which is the controlling factor.

A suspension of bacteria in salt solution was placed in a small well, 1 cm. beneath the surface of paraffin, and exposed for one hour, with the following factors: 135 K.V., 5 ma., 0 filter, and 10 in. focal distance. This experiment was repeated six times, but no inhibition was obtained.

Because paraffin is of approximately the same density as the body tissues, I, at first, thought it would be useless to attempt a similar experiment in meat. However, curiosity led me on, as, after all, I am personally interested in the practical, more than the academic, application of this work. For this experiment in meat, I took a small gelatin capsule and coated it inside and out with paraffin in order that neither the juice of the meat nor the bacterial suspension in salt solution within should dissolve the capsule. I used a capsule in order that I might be sure of getting as many bacteria in the suspension at the end of the treatment as were present before it was started. The same fac-

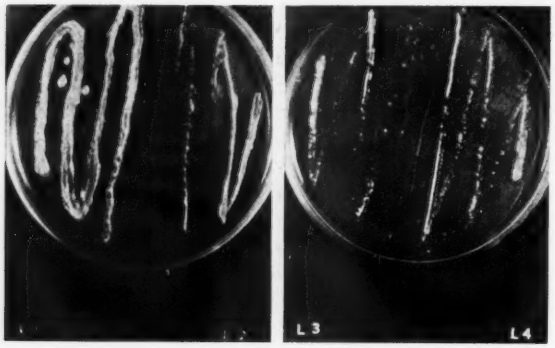


Fig. 2 *(first plate).* Lipiodol. *L*-1, Staphylococci mixed with lipiodol—control. *L-2,* Staphylococci mixed with lipiodol for three hours—control. *L*-3, Staphylococci mixed with lipiodol and treated with x-rays for five minutes. *L*-4, Same staphylococci and lipiodol, treated for ten minutes.

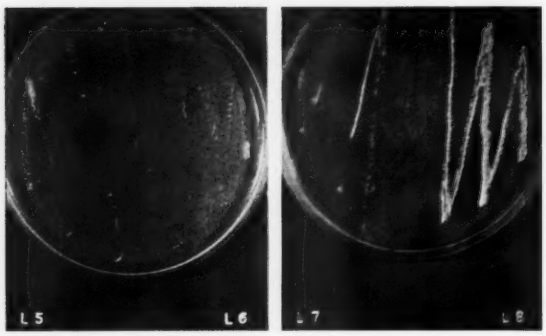


Fig. 2 *(second plate).* Lipiodol. *L*-5, Same mixture as shown in first plate, treated for thirty minutes. *L*-6, Same mixture, treated for sixty minutes. *L-7,* Same as *L-6. L-8,* Same mixture, untreated for sixty minutes—control. X-ray factors: same as used on Beck's paste.

tors of exposure were used as in the paraffin experiment. This procedure was followed six times and in each experiment there was some inhibition of growth after one hour of treatment. I cannot explain the difference in my finding between paraffin and meat, unless there are sufficient atoms of high atomic weight in the protein molecule to produce more secondary radiation than the paraffin does, and so inhibit the bacterial growth.

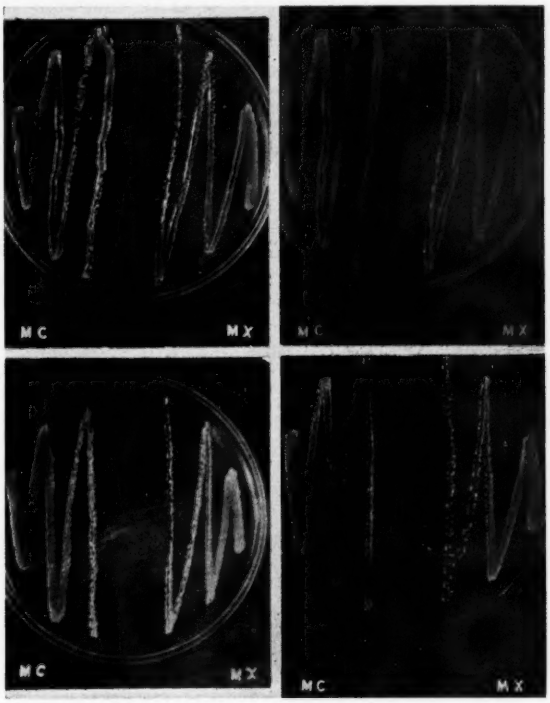


Fig. 2 *(third plate).* Meat. *MC,* Staphylococci suspended in normal salt solution after standing for one hour in a paraffin-coated gelatin capsule—control. The suspension was thoroughly mixed just before the culture was made. *MX,* Same suspension, in small paraffin-coated gelatin capsule buried 1 cm. in piece of lean meat 6 × 6 × 6 in., and treated for one hour with x-rays. The suspension was again thoroughly mixed just before the culture was made. X-ray factors: 135 K.V., 5 ma., 0 filter, 10-in. distance.

Using Beck's paste and the factors 110 K.V., 5 ma., 0 filter, and 10 in. focal distance, it was also found that, by making subcultures at different levels from the surface down, inhibition decreased accordingly. The greatest inhibition is at or near the surface, and the least at the bottom, after one hour of exposure. This would be expected, due to the absorption of the x-rays.

There was no difference found in the surface inhibition of Beck's paste, after one hour's exposure, by using either 110 K.V. or 135 K.V., other factors being the same (Figs. 1 and 2).

I am indebted and deeply grateful to Dr. Frances A. Ford, who assisted me in looking up the literature on this subject. The only reference found was that of Pauli and Sulger, who mixed colloidal gold solution with agar (4). To this, bacteria were added and the mixture was poured in a plate. A

portion of the plate was exposed to x-rays. The authors reported: "Colloids, through their secondary rays, increase the bactericidal effect of roentgen rays." A more thorough search of the literature will be made and reported in a later paper, if any other work of this nature is found.

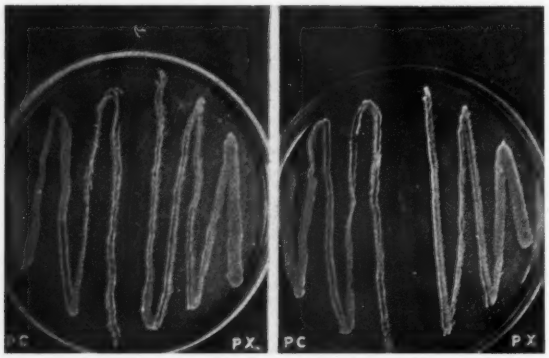


Fig. 2 *(fourth plate).* Miscellaneous. *PC,* Staphylococci suspended in normal salt solution after standing for one hour—control. *PX,* Same suspension as above, placed in a small well 1 cm. beneath the surface of paraffin and treated by x-rays for one hour. The same x-ray factors were used as for meat.

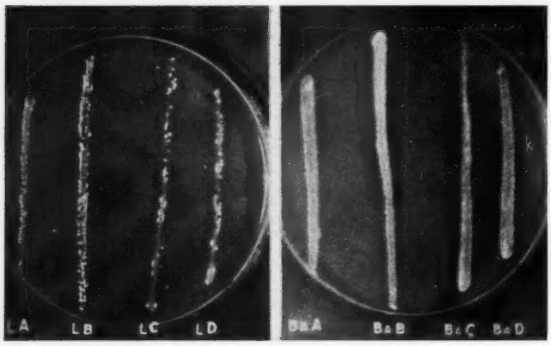


Fig. 2 *(fifth plate).* *LA,* Staphylococci mixed with lipiodol. *LB,* Same mixture, after standing for one hour. *LC,* Same mixture, treated by x-rays (110 K.V., 5 ma., 0 filter, 10 in.) for one hour. *LD,* Same mixture, treated by x-rays (135 K.V., 5 ma., 0 filter, 10 in.) for one hour. *BaA, BaB, BaC, BaD,* Same as above, except that the staphylococci were mixed with barium sulphate suspension instead of lipiodol.

DISCUSSION

The technic used in these experiments does not provide for a determination of the percentage of inhibition in bacterial growth. It is subject to criticism because one cannot always obtain the same amount of material in the platinum loop for subculturing. In spite of this, the fact that each experiment shows the same relative end-result on repetition warrants the conclusion that there is a decided inhibitory action on the growth of bacteria when they are treated in the presence of Beck's paste and lipiodol. Furthermore, there is evidence of some inhibition of bacterial growth when they are treated in the presence of meat. Just what the agent

is in these three substances which activated the x-rays, or is activated by the x-rays, is not proved. It is my opinion that the action is brought about through the secondary radiation emanating from the heavy metal present.

In view of these findings, we have at our disposal a means of treating deep-seated infections with sinus formation. We have a means of treating bronchiectatic lung abscess formation without surgery. And, finally, we have a means of explaining, at least in part, the beneficial results obtained from the x-ray treatment of skin infections. While bacteria are not completely inhibited even after one hour of exposure in the presence of meat, it is possible that they are stunned sufficiently to make it easier for the immunizing agents of the body to do their work. Just how true these conclusions are remains to be proved. I am reporting my work up to date in the hope that it will stimulate further work along this line of thought by men who have greater facilities and more material with which to work. In the meantime, I shall continue the work myself and hope to have something more worth while to report at a later date.

SUMMARY

1. There is a marked inhibition of bacterial growth when bacteria are treated by x-rays in the presence of Beck's paste and lipiodol.

2. There is some inhibition of bacterial growth in the presence of meat after one hour of exposure to x-rays.

3. These findings warrant additional work to determine their practical value.

REFERENCES

(1) Beck, Emil G.: The Bismuth Paste Treatment in Ear, Nose, and Throat Affections. Ill. Med. Jour., 1909, XV, 77-81.
(2) Idem: Fistulous Tracts, Tuberculous Sinuses, and Abscess Cavities: A New Method and Treatment by Bismuth Paste. Jour. Am. Med. Assn., 1908, L, 868-872.
(3) Klövekorn, G.: Effect of X-rays on Bacteria. Strahlentherapie, 1925, XX, 354-377.
(4) Pauli, W. E., and Sulger, E.: Über die baktericide Wirkung der Röntgenstrahlen. Strahlentherapie, 1929, XXXII, 761-768.

THE CLINICAL SIGNIFICANCE OF DUODENAL STASIS[1]

By SIDNEY A. PORTIS, M.D., Chicago

So much has been written on this subject that one wonders what new can be added to the voluminous literature; however, as one follows this extensive subject, he is clinically impressed with the lack of emphasis and proper clinical interpretation that is placed upon temporary delay in the duodenum. I will not burden you with the well known causes of duodenal ileus, a subject that has seemed to take both internists and surgeons by storm, so to speak, nor will I review the definite roentgenologic evidence accompanying the prolonged delay and passage of chyme to the various portions of the duodenum, for this x-ray evidence is better known to you than to me. What I am particularly interested in presenting is the clinical significance of the so-called temporary delay which can be more properly termed "stasis."

The physiology of this portion of the gastro-intestinal tract is not emphasized, nor is the biochemical phenomenon that ensues from temporary delay properly appreciated. The exact relation of gastric motility to duodenal motility is still a mooted question. Some hold that gastric movements end at the pyloric sphincter; others believe that at least in some cases the gastric wave of contraction passes down over the duodenum. In interpreting the facts on the relation of gastric motility to duodenal peristalsis, ac-

[1]Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, St. Louis, Nov. 30–Dec. 4, 1931.

according to Ivy (1), at least four possibilities must be considered:

(1) Excitatory impulse or wave of conduction may pass from the stomach to the duodenum without the actual wave of contraction passing.

(2) The relative amotility of the cap, possibly due to anatomic relation and physiologic threshold of the relatively few contractile fibers of this portion of the duodenum, may mask the passage of the wave.

(3) The threshold of the mucosa or the musculature of the cap may be higher than the remainder of the duodenum so that greater distention, prolonged chemical action, or a summation of the local or transmitted stimuli may be necessary to cause the cap to contract.

(4) The duodenal peristalsis may be initiated almost immediately on the ejection of chyme from the stomach, due to the mechanical or chemical stimulation of the mucosa.

The observations of Wheelon (2) direct attention to another portion of the duodenum in which a tendency toward retention exists, namely, the inferior flexure. This is commonly the lowest point of the duodenum, and peristalsis must overcome the effects of gravity, lifting the contents to the fixed portion of the duodenum. Any extrinsic pressure on the fixed portion of the duodenum necessarily increases this delay. Hence, the tendency toward retention in the inferior flexure is relatively insignificant, with respect to the etiology of chronic duodenal dilatation, but does enter into the discussion of temporary duodenal stasis. The results of the experiments of Dragstedt and Dragstedt (3) show that the circular extrinsic pressure equal to six inches of water exerted by a light condom rubber band is sufficient to cause acute duodenal obstruction and death. An extrinsic pressure of less than six inches of water would lead to partial obstruction, with the usual concomitant phenomenon of hyperstalsis, dilatation, with some hypertrophy, intermittent nausea and vomiting, and mild toxemia.

Reverse movements of the duodenum occur under normal and abnormal conditions. They occur normally in many individuals at the end of a meal at the time chyme is being ejected into the duodenum. This is a well known fact. Such reverse motility may not only be due to enteric reflexes, but may occur by reflexes of the celiac ganglion. Reverse motility of the duodenum occurs abnormally in various conditions. Many have observed it in vomiting. Henderson (4) has reported reverse movements as present in 93 per cent of patients affected with hookworm. Friedman, Strauss, and Arens (5) have seen them in many patients with gallbladder disease and believe they are due to an associated duodenitis. Reverse movements of the duodenum will in all probability be associated with any condition that increases the motility of the duodenal mucosa or musculature. Brunemeier and Carlson (6) found that stimulation of the duodenum inhibits the motility of the emptying of the stomach. Wheelon and Thomas (7) observed that elevations of duodenal tone are associated with a reduction of gastric antral waves.

Although subject to the motor drive of the stomach, the duodenum possesses a mechanism for controlling this action, as shown by the observations cited. This is clinically manifested in the symptoms attributable to visceroptosis, with associated atony of the stomach. The relief or displacement of the stomach upward naturally encourages decreased duodenal stagnation and, therefore, automatically increases the gastric peristalsis. While it was formerly thought that the symptoms attributable to visceroptosis were those of reflex disturbances associated with a pull and drag on the various plexuses in the abdomen, we have now come to believe that the most important feature of visceroptosis is this apparent delay in emptying the duodenum and the associated

pathologic physiology that necessarily accompanies it. Vomiting is more readily elicited from duodenal than from gastric irritation, and while the voluntary vomiting impulse caused by pharyngeal and gastric irritation may be inhibited, it is not so true of the duodenal type which is more rapid and violent in its onset. The observations of Burget (8) and of Graham (9) and his associates have shown that the tonus and motility of the duodenum play a fundamental rôle in the passage of bile from the gall bladder and biliary passages. It is not at all improbable that the hypertonus, amotility, and reverse movements of the duodenum may be important etiologic factors in disease of the biliary passages. I have become more and more convinced from my observations, both clinically and roentgenologically, that the early symptoms of cholecystic disease are primarily due to neuromuscular disturbances of the antrum, duodenal cap, and the second and third portions of the duodenum. Disturbances of this portion of the gastro-intestinal tract can easily account for the classical picture presented by early gall-bladder disease. However, when the disease takes a more chronic form, with its pericholecystitis and associated hepatitis, other factors enter into the clinical picture, which not only aggravate and modify the early symptoms but warrant surgical interference.

The secretions of the duodenum play only a minor rôle in digestion; however, the neutralizing ability of these secretions is very important. The duodenum is intimately related to the secretion of the stomach as well as to that of the pancreas. The duodenum can absorb substances from its lumen, such as water, glucose, alcohol, and crystalloids (potassium iodide and sodium chloride), quite rapidly. Because of the relatively rapid passage of the contents through and the incompleteness of the digestion of food when it enters the duodenum, probably a small amount of absorption occurs in the duodenum during the normal digestive processes. In duodenal obstruction, toxic substances pass into the circulation from the lumen, which under normal conditions does not occur to a great extent. It is commonly stated that distention causes a disturbance or a breakdown in the normal processes concerned in absorption. Stimulation and irritation of the duodenum cause the patient to experience nausea, which is one of the most frequently observed symptoms elicited by duodenal stimulation. Pain is frequent in its occurrence and distention or spasm seems to cause it. Strouse (10) reported years ago that the distention of the duodenum with a balloon caused a similar sensation to that seen in the usual type of biliary colic. Uneasiness, faintness, dragging and swaying sensations, vertigo, chilliness, and pallor are other symptoms associated with duodenal irritation. Alvarez (11) has suggested reverse movements as the cause of nausea and vomiting; however, if these movements are not the cause of nausea, they are usually associated with nausea and vomiting elicited by duodenal stimulation.

Delay in duodenal evacuation from whatever cause may produce definite general changes, their severity depending upon the degree and duration of the obstruction. The resultant clinical, pathologic, and biochemical phenomena have received considerable attention from the experimentalists and, more recently, their proper evaluation from clinicians. It is well known that if allowed to go unchecked, these changes may result in severe toxemia, nervous syndrome designated as tetany, and even death. All investigators of this subject have agreed that these general changes are brought about by some toxic agent, the source of which is believed by many to be in the duodenum, the exact agent being unknown. Recent investigations of the acid-base equilibrium in pathologic conditions have been slowly adding to our knowledge of the factors involved in the maintenance of this equilibrium. Although the practical aspects of this problem

are appreciated by the clinicians, the observations and discussions have concerned themselves in those cases in which equilibrium has been shifted to the acid side, this probably because of the greater frequency with which acidosis is encountered or recognized. Observations of upper intestinal obstruction indicate that an alkalotic condition of the body is as important as an acidotic state, if not more so. Gamble, Ross, and Tisdall (12) have shown that there is a regulatory mechanism in the body which tends to keep the fixed base in the blood constant, so that if salts of other acids are present in increased quantity in the blood, a migration of sodium chloride into the tissues occurs, leaving the fixed base relatively constant. It is a disturbance of this acid-base balance, produced by a toxic agent or agents, which results in the clinical syndrome, known as alkalosis, or alkalemia, and extreme manifestations, tetany, and death.

There is much experimental and clinical evidence to support this point of view. The derangement of the body chemistry is one of the outstanding features of duodenal intoxication. It includes changes of the blood, consisting of alteration in the plasma chlorides, the acid-base balance, and the non-protein nitrogen of the blood. These changes manifest themselves in a drop in the plasma chlorides, a shift of the acid-base balance to the alkaline side, as evidenced by an increase in the plasma carbon dioxide and the hydrogen-ion content of the blood. The nitrogen change is associated with a disturbance of the acid-base equilibrium of the kidney, necessarily raising the so-called renal threshold for its secretion.

It is possible to find first an acid urine in severe alkalosis, and it is probably associated with the presence of organic acids. Another finding that may be disconcerting is the presence of acetone bodies in the urine. While acetonuria is usually interpreted as indicative of acidosis, it has been shown that a ketonuria may result from the administration of large doses of sodium bicarbonate. Morris (13) has shown that in experimental alkalosis produced in cats and dogs, alkalemia decreases the oxidation of arterial blood and still more greatly diminishes the amount of oxygen given up to the tissues. With this anoxyemia it is conceivable that combustion of various food elements may be disturbed. Should this occur in the case of fats, the ketone bodies—evidence of incomplete fat combustion—may appear in the urine.

With the above physiologic and biochemical facts in mind, we can then consider that a potential alkalosis may accompany temporary duodenal stasis. It is on this basis that we can more readily explain the phenomena seen on fluoroscopic examination. However, the roentgenologist, knowing little of the clinical picture of the patient, is at a loss to put proper emphasis on these findings, and merely notes them in passing. There seems to be a definite lack of interest and also comprehension as to their importance. My interest in this subject is not purely one just of observation of associated symptoms with duodenal stasis.

In perusing the literature, both clinical and experimental, it is interesting to note that the references are made to a potential alkalosis but the suggestions for treatment are based purely on bed rest and diet. In many cases the patients have responded to this form of management. However, little emphasis is put on any additional medicinal therapy.

My observations of mild stasis within the last three years have impressed upon me the need for changing the acid-base equilibrium of the blood, an important factor in ameliorating this condition. I have chosen one of the two following methods, or both in some cases, depending upon the clinical picture of the patient. In these patients who show a very definite increase in the carbon

dioxide combining power, with an alkaline urine and the presence of normal acids in the stomach, I have found the liberal use of dilute hydrochloric acid after meals a valuable aid. This is not without long continued clinical experience, because many of the older clinicians in treating dyspepsia found that in giving hydrochloric acid after meals the patients showed improvement. They, however, knew nothing of the biochemical factors associated with dyspepsia.

Secondly, I have found that in a certain group of cases not associated with gall-bladder disease, in which the patients tolerate fats well, a ketogenic diet may bring about the desired result. This ketosis relieves the potential alkalosis, which is especially of value in cases of visceroptosis uncomplicated by gall-bladder disease, with associated duodenal stasis.

While this method of approach is not 100 per cent effective in all cases, I have been so clinically impressed with its results that I am reporting it at this time. My experience with a large number of cases of duodenal stasis is sufficient at the present time to allow me to draw some specific, as well as general, conclusions, which are as follows: (1) that the early symptoms of gall-bladder disease are associated with potential alkalosis; (2) that this alkalosis is a factor in producing distention, nausea, and belching, and when more marked, vomiting occurs; (3) that while the gall bladder may be a factor in producing temporary duodenal stasis, the symptoms that accrue to it are not due primarily to gall-bladder disease but to disturbance in the motility of the antrum, duodenal bulb, and second and third portions of the duodenum; (4) that if in early gall-bladder disease one can shift this potential alkalosis to an acidosis, definite relief may be seen in a large number of cases; (5) that if the peristalsis of the duodenum and the emptying of the duodenum are increased, it necessarily follows from the physiologic facts outlined that the motility of the stomach is also increased (this is classically shown in cases of visceroptosis), and (6) that when duodenal ulcer and duodenal stasis or stagnation co-exist, as in a certain percentage of cases associated with gall-bladder disease or without gall-bladder disease, it would then seem rational that alkaline therapy would not be as effective as in simple uncomplicated ulcer, and this seems to be clinically true.

In this group of cases I have found it well not to use the ordinary types of alkalies but to substitute for them the tertiary salts of calcium and magnesium phosphate. The results have shown definite clinical improvement. Many patients who do not respond to ordinary alkaline therapy are thought to have stubborn ulcers, and in many instances gastro-enterostomy is performed. While the acidity of the duodenum is lowered, the factors concerned in producing a potential stasis in the second portion of the duodenum are not modified, and many patients still persist in their symptoms of nausea and associated phenomena. One wonders whether or not, in this particular group of cases in which stasis is very marked, duodenojejunostomy may not be the better surgical procedure.

Further, it is to be remembered that long continued alkaline therapy in these cases with duodenal stasis may so change the acid-base equilibrium to the alkaline side that it may lead to definite renal impairment.

I have purposely left out of this discussion chronic duodenal ileus, because its symptomatology and surgical treatment are well known to you. For the same reason I have also omitted the roentgenologic evidence. However, I want, particularly, to emphasize that many of the so-called neuroses of the upper abdomen, which have been called functional disturbances and which often give rise to many psychiatric problems, can in many cases be explained

on the basis of duodenal stasis of a mild or severe grade.

CONCLUSIONS

1. Duodenal stasis is either a definite entity or a part of a disturbed motility, associated with other disease in the abdomen, or the result of a mechanical factor, as in visceroptosis.

2. The disturbed physiologic and biochemical phenomenon that ensues explains many of the symptoms attributable to it.

3. Changing a potential alkalosis to that of an acidosis brings about in many cases relief of the symptoms.

4. What has been called abdominal neurosis for the most part is often associated with temporary delay in the duodenum.

REFERENCES

(1) Ivy, A. C.: Radiology, July, 1927, IX, 47.
(2) Wheelon: Jour. Am. Med. Assn., March 3, 1923, LXXX, 615.
(3) Dragstedt, C. A., and Dragstedt, L. R.: Jour. Am. Med. Assn., 1922, LXXIX, 612.
(4) Henderson: Jour. Am. Med. Assn., 1925, LXXXV, 1462.
(5) Friedman, Joseph C., Strauss, Alfred A., and Arens, Robert A.: Radiology, August, 1925, V, 93.
(6) Brunemeier and Carlson: Am. Jour. Physiol., 1915, XXXVI, 191.
(7) Wheelon and Thomas: Am. Jour. Physiol., 1912, LIX, 72.
(8) Burget: Am. Jour. Physiol., 1925, LXXIV, 583.
(9) Graham: Proc. Inst. Med. Chicago, 1926, VI, 88.
(10) Strouse, Solomon: Trans. Assn. Am. Phys., 1925, XL, 296.
(11) Alvarez: Am. Jour. Med. Sci., 1919, CLVIII, 609.
(12) Gamble, Ross, and Tisdall: Jour. Biol. Chem., 1923, LVII, 633.
(13) Morris: Brit. Jour. Exp. Path., 1922, III, 101.

DISCUSSION

Dr. Horace W. Soper (St. Louis, Mo.): The treatment of this condition has been very unsatisfactory, I am sure, in most of our hands. We have had a number of cases in which we have proved that duodenal stasis was produced by adhesions. We have secured very good results by operative treatment in releasing the adhesive bands binding down this portion of the duodenum. Again in visceroptosis, particularly the acquired form, the diastasis of the lower recti muscles leads to duodenal stasis which is benefited by proper abdominal support.

One of our patients, who had had a pyloroplasty for ulcer, was left with quite a large dilated duodenum and considerable stasis. She presented the classical symptoms of duodenal stasis. Finally an entero-anastomosis was done and adhesions were found to account for the tremendous dilatation of the duodenum. The entero-anastomosis was not successful, and the patient had recurrent attacks of this toxic condition. Finally we resorted to the time-honored remedy that, I believe, is used only in the Southern States and in the Mississippi Valley, namely, giving a dose of calomel periodically every two weeks, followed in the morning by a good dose of the double salt of magnesia and sodium sulphate. The woman is now getting along fairly well. I may have the opportunity of trying out on this patient the new treatment suggested by Dr. Portis.

Dr. Portis (closing): I purposely omitted taking up the question of cases of adhesions or duodenal ileus that are primarily surgical, because most physicians to-day are agreed that duodenojejunostomy should be performed in chronic duodenal ileus producing a disturbed emptying time of the stomach. With ordinary methods of therapy patients presenting stasis continue to have their symptoms, and I wanted to emphasize that particular phase of the subject.

I quite agree with Dr. Soper when he says the time-honored remedy of giving purgatives and calomel will sometimes produce results. But it is to be remembered that anything that stimulates the duodenum stimulates the small intestine and the large intestine, causes an earlier emptying of the duodenum, and, naturally, relieves this so-called temporary stasis. Purgation effects the same result as the giving of hydrochloric acid to induce a more rapid emptying of the duodenum, but the latter does not disturb the rest of the gastro-intestinal tract, and I think it is a much more physiologic and superior method.

A SIMPLE INTEGRATING DOSIS MEASURING INSTRUMENT[1]

By A. MUTSCHELLER, PH.D., NEW YORK

1. AN integrating type of X-ray dosis meter has advantages that are most valuable in clinical radiation therapy. If errors are made in the adjustment of the usual constants, such as distance, tube current, voltage, filters, or even if changes in tube efficiency occur, they are either revealed during the treatment or they are accounted for in the total dosis applied to the skin. Hence the occurrence of skin injury or other damages, which in legal controversies are likely to be interpreted as avoidable carelessness, is totally avoided. However, if the reliability of such an instrument is lowered because it is unduly complicated or liable to get out of order, then its practical value is proportionally decreased.

2. A dosis meter is described here which offers some distinct advantages over those already in use. Several of the disadvantages of instruments of this type are eliminated through the use of a new type of trigger or "glow relay tube"[2] through which considerably more power for actuating the recording devices is obtained without the necessity of any further amplifying devices or radio tubes. Also the absence of tubes with filaments, and the elimination of storage batteries required to energize such filaments, is an advantage through which the reliability and ruggedness of the device are much increased.

3. The glow relay tube has three similar electrodes of thorium, which, however, are placed in a particular relation to one another. One electrode serves as common cathode for the other two. In series with the third electrode, the main anode is connected to the relay or other indicating or recording device. The short distance between the cathode and the third thorium anode provides a small gap which is easily bridged by a discharge taking place when a definite positive voltage is applied to this starting, or relay, anode. At the moment discharge sets in, a larger discharge takes place between the main anode and the cathode and, therefore, the recording devices connected in series with that circuit respond and register. This tube, therefore, performs in every way the function of a relay or trigger device. The space within the bulb is prepared and evacuated so that a partial atmosphere of pure argon remains.

4. The radiation dosis is measured with an ionization chamber of the standard thimble type. It is to be calibrated in international r units by comparison with a standard ionization chamber and checked for wave length independence over the wave length range for which it is to be used.

5. The ionization current flowing through the chamber, which is proportional to the x-radiation intensity, is caused to accumulate upon the well insulated anode in the glower tube until a definite voltage has developed. The electrode is placed in proper proximity with a specially constructed negative electrode so that, at the moment when a definite voltage has been developed, there is set up in the glower tube an ionization discharge which initiates in it a separate circuit with the flow of an ionization current of sufficient magnitude to operate a relay and a counting or recording mechanism. Therefore, every time a certain definite quantity of radiation intensity has fallen upon the ionization chamber, the glower tube functions and an audible click is heard, with registering of the counting mechanism.

6. To compensate in the simplest man-

[1]Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30–Dec. 4, 1931.

[2]RENTSCHLER, H. C.: Trans. A.I.E.E., 1930, XLIX, 567.

ner for all possible variations, there is provided a radiation standard which can be switched into the circuit in place of the ionization chamber. Furthermore, a variable condenser is provided for the purpose of adjusting the sensitivity of the device. Hence, to make a complete adjustment of the instrument, the condenser is varied until, with the uranium oxide standard switched in, the time interval between clicks is the same as that for which the instrument is calibrated. Of course, adjustment is made while no X-rays fall upon the ionization chamber, and so abnormal factors leading to errors, such as abnormal voltage on the ionization chamber or the glower tube, leakage, etc., are either immediately discovered or they are adequately compensated for by the adjustment.

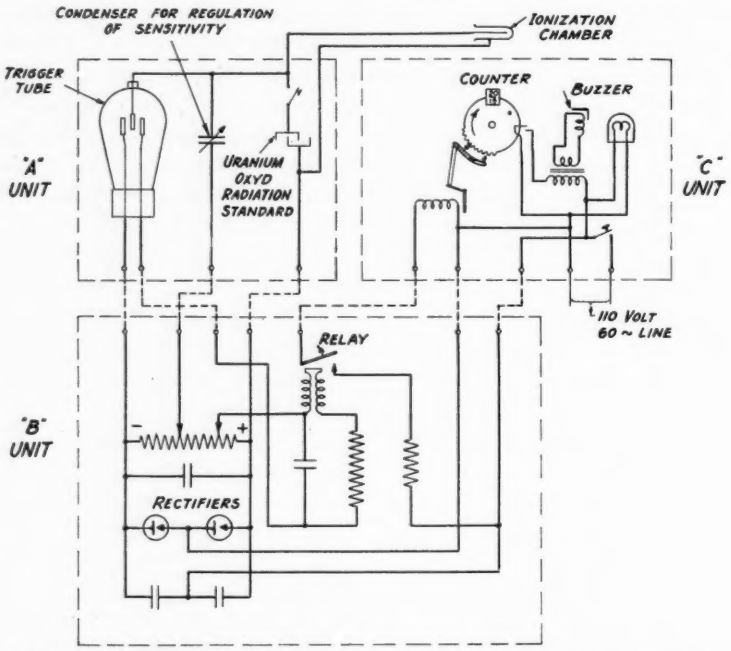


Fig. 1. Schematic diagram of the glow relay tube as used in the integrating dosis meter.

7. The circuit and structural details of the glow relay tube are shown schematically in Figure 1. The parts grouped within the dotted line and marked "A Unit" are mounted and assembled in an apparatus that is to be placed near the patient at a suitable height so that the ionization chamber rests on the part to be irradiated or treated. This is easily accomplished with the aid of a special rack and pinion movement operated with a crank handle. A single cable containing three wires connects from this unit to the part marked "B Unit."

8. The box housing "Unit B" contains a small transformer, valve tube, chokes, and condensers to generate from ordinary A.C. house lighting current, the direct current voltage required for the ionization chamber and the glow relay tube. In this unit, which is conveniently placed near the control board and the operator, there are also a relay and counting device with an indicating dial which is located on the front panel of the box.

9. For practical use, the instrument is connected to the power supply line and then, while no X-rays fall upon the ionization chamber, the uranium oxide standard is switched in. The time interval between the

clicks is measured with a stop watch. If the time between clicks is not the same as that determined for the particular uranium oxide standard by calibration, then the variable condenser is either increased to make the time between the clicks longer, or decreased if the clicks occur too frequently. After this adjustment is made, the uranium oxide standard is switched out and the instrument is used for measuring the X-radiation dose.

10. The usual calibration of the instrument is based upon the fact that between any two clicks, a current of three (or five) electrostatic units per unit volume is passing through the ionization chamber. These, then, correspond to a radiation intensity of three (or five) r units under standard conditions of pressure and temperature. Therefore, the total treatment dose is divided by three (or five) to find the number of clicks, or the number of changes of the figures on the counting device, required to make up the dose.

11. The integrating dosis measuring device is presented because it possesses the advantage of much greater simplicity, compactness, and ruggedness over the instruments now in use for a similar purpose. Greater reliability is secured in measuring the dose applied directly to the skin of the patient and, in general, there is less danger of errors and accidents.

DISCUSSION

DR. E. A. POHLE (Madison, Wis.): I am very much in favor of the development of an integrating dosimeter which is simple, rugged, reliable, and foolproof. I believe the ideal method of applying X-rays accurately is to place a chamber on the patient and to record the dose during the entire treatment, not using the method of dosing by time.

DR. ROY KEGERREIS (Chicago, Ill.): Dr. Mutscheller and his associates should be congratulated on having brought out this "click" instrument. Its use involves the element of time, one has to wait a little bit, and it is not an indicating instrument, but I am quite sure it will appeal to radiologists. It is simple in operation and has a tremendous range in sensitivity.

X-RAY IN THE DIAGNOSIS OF RENAL TUMORS AND POLYCYSTIC KIDNEYS[1]

By JOHN R. CAULK, M.D., Professor of Clinical Urology, Washington University, SAINT LOUIS

NINE years ago, it was my privilege to speak before this Society on the relation of radiology to urology and to welcome the partnership existing between our two branches of medicine. To-day we find this bond even closer. This close affiliation is particularly essential in the radiologic diagnosis of renal tumors and polycystic kidneys.

It is manifest that either urology or radiology alone is inadequate to explain the diagnostic intricacies of renal tumors, and even their combined efforts occasionally fall short, the aid of other general and special studies being sought. Many of these, however, are dependent upon the x-ray and demand complete gastro-intestinal configuration and cholecystography, as well as general skeletal studies and roentgen-ray examination of the chest for metastatic changes. Study of the genital tract in male or female may disclose the primary cause of some vague abdominal or retroperitoneal tumor. Provided all renal neoplasms uniformly presented the symptom-complex of tumor, pain, and hematuria, the task of diagnosis would be simplified, but only one-third of the cases record all three, hence the need for detailed study.

My listeners' familiarity with this subject

[1]Presented before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30–Dec. 4, 1931.

makes it extremely difficult for me to offer any novel features; hence in this presentation I can do no more than refresh your memory with some of the standard facts in diagnosis and possibly suggest a few points which may elicit discussion.

Thoroughly to differentiate renal tumors, it is necessary to consider not only new-growths of the kidney but other pathologic processes such as severe infections (with or without calculus), tuberculosis, parasitic diseases, large hydronephroses, abnormal movability, and congenital malformations which may bear a close resemblance to neoplasms. The larger growths often require accurate differentiating from gall-bladder and splenic conditions, intestinal tumors and retroperitoneal masses. Again, we must be equally alert to the changes in the pelvic outline in cases presenting symptoms suggestive of tumor but without visible or palpable evidence of the growth, such as those occurring from small neoplasms invading a localized area of the kidney substance and pelvis, tumors within the pelvis, and filling defects produced by less serious causes such as those created by spasm, soft stones, aberrant vessels, granulomas, and vascular changes. Both groups offer many complex problems.

Since we are dealing with the value of radiology in the diagnosis of such tumors, other diagnostic aids will receive no comment, assuming, of course, that a thorough medical investigation has been made. The size, contour, presentation, location, and the relation to other viscera, particularly the bowel, are helpful aids, but ultimately the combined efforts of urologists and radiologists are necessary for the differentiation of abdominal tumors. The plain x-ray, the so-called flat plate, may outline the growth and suggest it to be a renal shadow; however, an enlarged kidney shadow must not be relied upon too strongly as indicating a growth, since other factors, such as the size of the patient, the amount of fat, the type of exposure, the distance from the film, etc., may create this apparent enlargement. Very large tumors are seldom definitely outlined. The demonstration of shadows within the kidney regions strengthens the diagnosis of kidney disease, but the possible presence of an overlying gall badder, with stones, must always be borne in mind. Scattered indefinite shadows within the outline of a large growth are highly suggestive of calcification of a renal tumor. Tuberculosis may show a similar picture, and frequently soft calculi, calcifications, or inspissated pus in a pyonephrotic kidney, as well as calcification of glands, may be confusing. In symptomless renal tuberculosis there is a tendency for the calcification to be more pronounced.

Since there is no specific pelvic picture of a renal tumor and the pyelographic evidence depends upon the part of the pelvis invaded and distorted, one has to be extremely careful in its interpretation and no individual is capable of always making a positive assertion that tumor is present, in cases showing slight aberrations from the normal. Careful rechecking of such pyelograms must be done and the clinical picture must fit with the findings. Repeated studies are required. Localized substance tumors may occur without any interference with pelvic contour even in large growths of one or the other pole, and only change of pelvic position will tell the story.

The character of the deformity will naturally depend upon the part of the pelvis involved and may vary from a small exclusion of a part of a calyx to complete occlusion of the pelvis; the latter would be difficult to differentiate from a tuberculous renal occlusion were it not for other clinical factors. Even the localized lesions tending to amputate a calyx may find an almost similar reflection in certain tuberculous involvements; but when tumor isolates a calyx it is usually complete or the shadow diminishes from the pelvis to the cortex, whereas in tuberculosis complete isolation is seldom present and a partial one shows the narrow fillings

nearer the pelvis, with a tendency toward dilatation distal to it, due to abscess formations. Such dilatations do not occur in tumor. The changes in the ureter occurring in tuberculosis, as well as cystoscopic evidences of the disease in the bladder, assist in clearing the diagnosis.

In large growths involving the whole organ, the pelvis may be tremendously elongated and thinned out and even broken in its course, forming streaks of bizarre shape —the spider-leg pelvis, for example.

In large tumors involving the lower pole there is a tendency for the pelvic position to be lowered through traction. The course of the ureter is interfered with, being usually deflected inwardly with a rounded sweep across the spine. Smaller growths may interfere with the ureter but little through pressure, and produce only a slight kinking near the pelvis. Tumors of large size involving the upper pole are more likely to be fixed; the pelvic outline may not be so markedly depressed as in lower pole tumors, and rotation is less likely. The most pronounced pelvic rotation seems to appear in tumors originating below the mid-section of the kidney.

In differentiating large tumors of the liver, gall bladder, spleen, or bowel from renal neoplasms, one is often faced with a real task; yet, correlated with the general clinical picture, there are urologic and radiologic evidences which are definite. Tumors of the liver, gall bladder, and spleen seldom disturb the relationship of the renal pelvic outline and only occasionally distort the ureteral picture. In two instances I have seen large gall-bladder tumors carry the ureter inward, as is seen in large lower pole tumors of the kidney or in retroperitoneal growths, but this, in my experience, has been exceptional. The same applies to the spleen. Hence, if the pelvic outline remains apparently normal or slightly hydronephrotic, the growth is extra-renal.

In retroperitoneal growths, ureteral displacement is most pronounced. There is a tendency for an inward sweep over the spine, its length depending upon the size of the tumor; its outline is generally smooth unless disturbed by inflammatory adhesions or malignant involvement from the growth. The pelvic outline is either normally posed or occupies a higher position, depending upon the size of the growth, but shows no infringement or very little in proportion to the size of the tumor. If the ureter is involved, hydronephrosis may result. Gastro-intestinal radiography is then of paramount importance. Hepatic tumors depress the transverse colon; renal tumors rarely do. Splenic tumors tend to deflect the stomach and colon downward and inward. Renal tumors of large size, owing to their retroperitoneal position behind the ascending or descending colon, carry these structures inward, hence the evidences afforded by urographic studies coupled with information secured by gastro-intestinal radiology will usually suffice to localize the source of the tumor.

A tremendous retroperitoneal lipoma recently examined presented presumptive evidence of renal tumor; indeed, almost typical by palpation. Associated gastro-intestinal and urologic studies disclosed the tumor to be of extra-renal origin.

Congenital anomalies of the kidney occasionally offer diagnostic difficulties and may be confused with renal neoplasms, prominent among which are the large unilateral fused kidneys, horseshoe kidneys, abnormally large kidneys with double pelves, the so-called double kidneys, occasionally ectopic kidneys with pathological changes within them, and particularly polycystic disease of these organs. Tumors, of course, may occur in any of these anomalous kidneys; I have, however, never observed one in the polycystic organ. These conditions can be differentiated without difficulty through systematic uroradiologic studies.

From this realm of renal anomalies, poly-

cystic disease is our chief concern, since it may closely simulate a neoplasm. While this disease has a tendency to be bilateral, only one kidney may present noticeable evidence of growth, and, like renal tumors, may be associated with pain and hematuria. Clinical studies and our concerted efforts will generally solve the diagnosis. The pyelographic changes of a polycystic kidney may be variable, but they follow a much more characteristic course than do renal tumors. There is usually great lengthening of the calices and, with it, one seldom observes the fine linear streaks from compression such as are seen in renal tumors. The general outline of the calices is smooth in the infundibular areas. The distal parts of the calices show a decided tendency to dilatation, while the pelvis is distorted throughout its outline, in contradistinction to the pelvis of the renal tumor which may be normal in one portion and completely disrupted in the other. Since the disease is so frequently bilateral, the pelvis of the mate will usually show similar disturbances. Such pelves cover more territory than any other type unassociated with general dilatation.

There is probably no more perplexing problem in radiologic study than the second group previously alluded to, namely, cases presenting evidences of renal tumor but without demonstrable growth. Here one is confronted with hematuria of renal origin, defective pelvic filling by pyelographic studies—usually without blood dyscrasias or disturbance of renal function. Small tumors involving a localized area of kidney infringing on a part of the pelvis or calices, require extreme care in diagnosis. Besides having to be differentiated from tuberculosis, as previously mentioned, equal scrutiny is required in ruling out such lesions as soft shadowless pelvic stones, filling defects of the pelves from muscle spasm, changes due to aberrant vessels, granulomas and the like, and particularly from clots resulting from idiopathic renal epistaxis. In such instances information secured from pyelograms taken during the process of hematuria is often deceptive—a small blood clot may be confusing. Such pyelograms must always be rechecked between bleedings. I have observed a number of cases with definite filling defects in the true pelvis and calices which showed no such evidence after bleeding had ceased. On the contrary, I have observed equal filling defects present themselves at the time free from bleeding, and, on rechecking, have noted their disappearance. Insufficient filling of a calyx, spasm of a calyx or a part of the pelvis which may be physiologic must always be taken into consideration and can only be proven by careful re-investigation. Persistent defects within the pelvis or calices may represent granulomas, papillary tumors of the pelvis, or soft calculi, and, if symptoms persist or recur, exploration is required. Topographical changes in the ureter, associated with filling defects in the pelvis, often offer corroborative evidence of tumor, owing to the pronounced tendency of papillary tumors of the pelvis to transplant in the ureter.

We are probably of one accord in urging repeated studies in such problematical pelves, and are familiar with the physiologic changes due to smooth muscle contraction as they vary from systole to diastole, and simulate localized defects.

I have been definitely impressed with the fact that intravenous urography in the differential diagnosis of renal tumors offers less reliable evidence than does retrograde pyelography, since the detailed configuration is less accurate, and, furthermore, as is the case in most renal diseases, the ureteral catheter is required not only to secure the urinary constituents from each kidney but to properly determine their comparative functions.

The proper correlation of radiology and urography will definitely prove the existence of renal growth or polycystic disease in the majority of cases.

TREATMENT OF CARCINOMA OF THE THYROID GLAND[1]

By JOHN DEJ. PEMBERTON, M.D., Division of Surgery, and ROBERT E. FRICKE, M.D., Section on Therapeutic Radiology, The Mayo Clinic, ROCHESTER, MINNESOTA

OUR purpose in this study is to come to a conclusion, if possible, concerning a rational method of treatment of carcinoma of the thyroid gland, giving due consideration to the type of carcinoma and its stage of advancement. Our conclusions will be based on comparison and evaluation of different methods of treatment which have been employed in the Mayo Clinic.

Carcinoma of the thyroid gland is unique among the malignant tumors. It arises, as a rule, in long-standing adenomatous nodules. As most writers on the subject have emphasized, it is impossible to recognize by clinical examination the early malignant changes. When the process has advanced sufficiently to permit of clinical diagnosis, any operation, except for palliation, is commonly of little avail. The rich blood supply of the gland and the proximity to the large cervical veins and lymphatic structures favor early metastasis, involving the regional nodes, lungs, bones, brain and other viscera. This peculiarity is so readily recognized now that discovery of a malignant bone tumor or of a carcinoma in a lung or other organ usually impels careful examination of the thyroid gland as a possible primary site of the growth. In some cases, carcinoma of the thyroid gland is first suspected after the finding of distant metastatic growths. Wilson (10) stated that correct early diagnosis of carcinoma of the thyroid gland is made less frequently than that of malignancy of any other organ.

Owing to the diversity of the histologic features of carcinoma of the thyroid gland and to their similarity to benign changes seen in the gland in response to various stimuli, pathologic diagnosis may be exceedingly difficult, even to trained pathologists. In 1924, from a study of a large series of carcinomas of the thyroid gland, Graham (4) pointed out the frequency with which carcinomatous cells actually invade the blood vessels, and concluded that this finding offered a more reliable criterion of carcinoma in certain types of tumors of the thyroid gland than did histologic cellular changes. Although most pathologists agree that the finding of invasion of vessels is evidence of malignancy, many do not depend on this to establish the diagnosis. They maintain that cellular invasion is not a constant feature of all types of malignant tumors of the thyroid gland; hence, for diagnostic purposes, absolute dependence cannot be placed on this feature. Instead, histologic cellular changes are considered to be more trustworthy.

Carcinoma of the thyroid gland occurs in three distinct types: (1) Papillary adenocarcinoma; (2) adenocarcinoma in adenoma, and (3) diffuse scirrhous adenocarcinoma. A fourth group may be added, namely, spindle-cell carcinoma resembling sarcoma. These vary widely, both in degree of malignancy and in their tendency to metastasize to distant organs. Of necessity, the results of any form of treatment vary with the types of carcinoma, which have been named practically in the order of their degree of malignancy; for instance, papillary adenocarcinoma is of a low grade malignancy and grows slowly, metastasis being almost limited to the regional nodes. The spindle-cell type, fortunately rare, grows speedily, produces distant metastasis, and is almost without exception rapidly fatal.

Before the advent of irradiation, operation was the only means of combating the

[1]Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30–Dec. 4, 1931.

disease. Results were not encouraging. In 1921, Wilson, reviewing all the literature on malignant tumors of the thyroid gland to that date, expressed his belief that one reason why relatively few cases were reported was the reluctance of anyone to report cases in which his treatment was futile. In advanced, inoperable conditions, palliative operation and sedatives were the only methods of relief available. The literature gradually increased. Herbst (5) reviewed surgical results at the Mayo Clinic up to 1921, and Pemberton (6) reported results at the same institution up to 1924. In the meantime, radiologists found that palliation could be obtained in advanced cases, with occasional cures, and that post-operative treatment secured better results than surgery alone. In this country excellent results were reported by Bowing (2), Pfahler (7), Portmann (8), and Craver (3), to mention only a few. Leading radiologists in Germany maintained that carcinomas of the thyroid gland are markedly radiosensitive (3).

The principles of treatment of carcinoma of the thyroid gland, as followed in the Mayo Clinic, have varied with the type of malignancy and the degree of involvement. We consider operable those cases without marked fixation to surrounding structures by invasion and without metastasis. On operation, the carcinoma is found to be confined within the capsule. In these early cases, removal of all the growth without rupture is ample; removal of further thyroid tissue is unnecessary. If, however, the carcinoma is not definitely encapsulated, total removal of the affected lobe, for these growths are usually confined to one lobe, is indicated. With late cases, further invasion and some degree of fixation of the tumor has occurred; metastasis may or may not be present. If, at operation, the growth can be removed, complete extirpation of the lobe is indicated, with subsequent irradiation. On exploration, if the local growth is found to be too adherent or fixed for resection, radium needles may be buried, 1 cm. apart, in the tumor. The needles we prefer now contain 1 mg. each, and the filter is 0.4 mm. of platinum. Silk threads are attached to the needles, so that the surgical wound may be closed, and the needles removed aseptically from 24 to 48 hours later. During the years reviewed in this study, we employed stronger needles, containing 5 mg. of radium filtered through steel alloy. These were placed 1 cm. apart and were left in place for a shorter time, usually from 14 to 24 hours.

Further external irradiation is given later during the convalescent period. In all surgical operations, whether early or late, a large rubber drainage tube is left in the cavity so that radium, on a lead stem, may be inserted into the depths. A 50-mc. tube of radon in a silver applicator is left in place for a dosage of from 200 to 400 millicurie-hours. During convalescence, external irradiation is also given. External irradiation may be given in all cases post-operatively, and also in the inoperable cases. This consists of checker-boarding the region of the thyroid gland in fields about 3.25 cm. square. The frontal and lateral regions of the neck are thus marked, and to each area, at a distance of 2.5 cm., 50 mg. of radium are applied, using three areas at a time, until the whole surface is treated and is given a mild erythema dose. At present, radium only is used in this fashion if pathologic examination has given evidence of lesions graded 1 or 2. For growths graded 3 and 4, supplementary high voltage roentgen treatment is given through a dorsal field. In the series here reported, moderate voltage roentgen rays were used until about the year 1924, when use of higher voltages became more frequent. Roentgen therapy was also applied to all distant metastatic growths.

Furthermore, the question of treatment of

TABLE I.—TREATMENT OF 161 CASES OF CARCINOMA OF THE THYROID GLAND

Group	Cases	Percentage	Treatment
Surgical (107)	50	46.73	Surgery and radium
	12	11.21	Surgery and roentgen rays
	35	32.71	Surgery, radium, and roentgen rays
Non-surgical (54)	10	9.34	Surgery only
	15	27.78	Radium only
	6	11.11	Roentgen rays only
	33 *	61.11	Radium and roentgen rays

TABLE II.—END-RESULTS IN 51* NON-SURGICAL CASES OF CARCINOMA OF THE THYROID GLAND

Length of life after treatment	Dead	Percentage	Living	Percentage
Less than 1 year	28	54.90		
1 year and more	8	15.69		
2 years and more	3	5.88		
3 years and more	3	5.88		
4 years and more	2	3.92		
5 years and more	1	1.96	1	1.96
6 years and more			2	3.92
7 years and more	1	1.96	1	1.96
8 years and more				
9 years and more			1	1.96
Total	46	90.19	5	9.80

*Three of the 54 patients who composed this group could not be traced, but were living when last heard from.

benign adenoma of the thyroid gland frequently arises. Since from 80 to 90 per cent of carcinomas of the thyroid gland arise in pre-existing benign adenomas, and in view of our inability to detect clinically early malignant changes in a nodular goiter, because of the high mortality of carcinoma of the thyroid gland in general, and the small operative risk in removal of simple adenomas, we believe that operation should be seriously considered as the treatment of choice for all adenomatous goiters.

The group selected for study consists of 161 patients treated at the Mayo Clinic from 1921 to 1926, inclusive. They were chosen to enable us to determine remote results of treatment over a period of from five to ten years. Actually, 213 cases of carcinoma of the thyroid gland were seen in this interval of six years, but 52 cases are not included, for the patients returned home for treatment following diagnosis at the clinic. The 161 cases reviewed are separated into a "surgical" group, in which treatment was by operation and irradiation, and a "non-surgical" group, in which only irradiation was given. The incidence of carcinoma of the thyroid gland is usually quoted as from 1 to 6.75 per cent (3, 9) of all cases in which the thyroid gland is the primary site of disease. In this period of six years, of 11,175 operations for goiter performed at the Mayo Clinic, carcinomas were found in 107 (0.96 per cent). The incidence in the non-surgical cases cannot be accurately determined, due to lack of biopsy in many of them.

In the non-surgical group of 54 cases, females predominated in a ratio of 1.34 to 1. The average age of the females was 51.90 years and of the males 53.13 years. This medical group comprised the hopelessly advanced, inoperable cases. In the surgical group of 107 cases, there was a still greater preponderance of females—the ratio was 3.28 to 1. The average age of the females was 43.27 years, and of the males, 50.88 years.

On analyzing the type of treatment given (Table I) it was found that, in the surgical group of 107 cases, operation and irradiation were employed in all but 10 cases (9 per cent). This small group of 10 cases, in which treatment was by surgery without irradiation, was not studied separately in compiling results, for reasons that will appear. Irradiation was omitted in three cases because of post-operative death: from surgical shock in one case, from post-operative pneumonia in a second, and from hemo-

TABLE III.—END-RESULTS OF 107* SURGICAL CASES OF CARCINOMA OF THE THYROID GLAND

Length of life after treatment	Classified by grade of malignancy								Classified by histologic type							
									Papillary adeno-carcinoma		Carcinoma in adenoma		Diffuse adeno-carcinoma		Spindle-cell carcinoma resembling sarcoma	
	Grade 1, cases	Percentage**	Grade 2, cases	Percentage	Grade 3, cases	Percentage	Grade 4, cases	Percentage	Cases	Percentage	Cases	Percentage	Cases	Percentage	Cases	Percentage
Less than 1 year			5	9.62	2	16.67	5	55.55			8	12.12	2	33.33	2	66.67
1 year and more	1	2.94	1	1.92	1	8.33					3	4.54				
2 years and more	1	2.94	2	3.85							4	6.06				
3 years and more	1	2.94	8	15.38	1	8.33	1	11.11	2	6.25	7	10.61	1	16.67		
4 years and more	3	8.82	2	3.85	2	16.67			3	9.37	4	6.06				
5 years and more	7	20.59	9	17.31	3	25.00	1	11.11	5	15.62	13	19.70	2	33.33		
6 years and more	6	17.65	11	21.15	1	8.33			8	25.00	9	13.64	1	16.67		
7 years and more	4	11.76	7	13.46	2	16.67	1	11.11	5	15.62	8	12.12			1	33.33
8 years and more	3	8.82	3	5.77					2	6.25	4	6.06				
9 years and more	7	20.59	3	5.77			1	11.11	6	18.75	5	7.58				
10 years and more	1	2.94	1	1.92					1	3.13	1	1.52				
Total	34	31.77	52	48.60	12	11.21	9	8.41	32	29.91	66	61.68	6	5.61	3	2.80

*Of 91 patients (85.05 per cent) traced, 58 (63.74 per cent) are living; 33 (36.26 per cent) are dead. Of the patients who were not traced, 16 (14.95 per cent) were living when last heard from.

**Each percentage in any given column is calculated on the basis of the total number of cases in that column. The percentage which corresponds with the total number of cases of a given column is calculated on the basis of 107 cases, or the total number of surgical cases in the series.

thorax and pulmonary metastasis in a third. In a fourth case irradiation was omitted because carcinoma did not appear in sections of the gland until review of the tissue was requested a few months after operation, when metastasis to bone had developed. In a fifth case, post-operative irradiation was given at home. The remaining cases of this group of 10 are too few to be considered separately for determination of purely surgical results. We noted, further, that, in the surgical group, evidence would indicate that all the carcinomas arose on a basis of preexistent goiter, either of the type of fetal or of colloid adenoma. In none of our cases did carcinoma arise in an exophthalmic goiter. The goiter was of

long standing, and growth had been noted for more than four years in the average case. The cases in the non-surgical group were advanced and inoperable, permitting clinical diagnosis. The growth of the pre-existing goiter averaged less than three years. Disregarding fractions, 61 per cent received treatment by both radium and roentgen rays; 28 per cent received treatment by radium only, and 11 per cent by roentgen rays only. In 31 of the 54 cases (57 per cent), biopsy was made.

The end-results in these advanced, non-surgical cases (Table II) treated by irradiation only were rather disappointing. We were able to trace 94.44 per cent of the 54 patients who were treated by irradiation only. Of these, 54 per cent died within the first year. Of the patients traced, five, or roughly 10 per cent, are still living: one for five years, two for six years, one for seven years, and one for nine years following treatment. Forty-six (90 per cent) are known to be dead. Biopsy was obtained, fortunately, in all of the cases in which patients are living. Two of the growths were papillary carcinomas, two were carcinomas in adenoma, and one was a diffuse adenocarcinoma. Two were of Grade 1 and three were of Grade 2.

The surgical group of 107 cases presented an entirely different picture (Table III). We were able to trace 91 patients (85.05 per cent). Of these, 58 (63.74 per cent) are still living and apparently well for from five to ten years after treatment. Thirty-three (36.26 per cent) have died. Of the 16 patients not accurately traced, approximately 15 per cent of the group, all were living when last heard from: two for nine years and more; two for seven years and more; two for six years; two for four years; four for three years; two for two years; one for a year, and one for less than a year since treatment.

We are indebted to A. C. Broders and W. H. Bueermann for the pathologic studies in this series of cases. Most of our surgical cases fall into the class of papillary adenocarcinoma or carcinoma in adenoma (so-called malignant adenoma). Both of these are usually of low grade malignancy, graded 1 or 2. The grade of malignancy of papillary adenocarcinomas is very low. As mentioned before, distant metastasis of these growths is uncommon; local extension to the cervical glands may occur, but recurrence is infrequent, permitting more radical operation, and the tumors are distinctly radiosensitive. The higher grades of malignancy are exemplified by diffuse adenocarcinoma and spindle-cell carcinoma resembling sarcoma. Fortunately these types are less common.

Among our 107 surgical cases, in 32 (29.91 per cent), the tumors were papillary adenocarcinomas; in 66 (61.68 per cent), carcinomas in adenoma; in six (5.61 per cent), diffuse adenocarcinoma, and in three (2.8 per cent), spindle-cell carcinoma resembling sarcoma. Taken by graded malignancy, the growths in 34 cases were of Grade 1; in 52 cases, of Grade 2; in 12 cases, of Grade 3, and in nine cases, of Grade 4. In our group of non-surgical cases, biopsy was made in 31 cases. In 10 cases, the tumors were papillary adenocarcinomas; in seven, carcinomas in adenoma; in nine, diffuse adenocarcinomas, and in five, spindle-cell carcinomas resembling sarcoma. Considered by grades of malignancy, the growths in seven cases were of Grade 1; in nine cases, of Grade 2; in five cases, of Grade 3, and in 10 cases, of Grade 4. The tendency here was definitely toward the higher grades.

Among the 58 patients of our surgical group who are still living (Table IV), the tumors of 25 (43.1 per cent) were papillary adenocarcinomas, and of 31 (53.45 per cent) carcinomas in adenomas. In only one case was the neoplasm a diffuse adenocarcinoma

TABLE IV.—TYPES OF CARCINOMA OF THE THYROID GLAND OF 63 PATIENTS WHO ARE LIVING AND 56 WHO ARE DEAD

Group			Papillary adenocarcinoma		Carcinoma in adenoma		Diffuse adenocarcinoma		Spindle-cell carcinoma resembling sarcoma	
		Cases	Cases	Percentage	Cases	Percentage	Cases	Percentage	Cases	Percentage
Living	Surgical	58	25	43.10*	31	53.45	1	1.72	1	1.72
	Non-surgical	5	2	40.00	2	40.00	1	20.00		
Dead	Surgical	33	3	9.09	25	75.76	5	15.15		
	Non-surgical	23**	7	30.43	5	21.74	7	30.43	4	17.39

*The percentages given in any horizontal line of this table are calculated on the basis of the number of cases given on the same horizontal line, in the column of figures furthest to the left.
**This represents the number of cases, among the non-surgical patients who have died, in which biopsy was obtained. Of the total number of 54 patients who were treated by non-surgical methods, 46 are known to be dead.

and in one a spindle-cell carcinoma resembling a sarcoma (1.72 per cent each). In grades of malignancy, 43.10 per cent of the growths were of Grade 1; 43.10 per cent, of Grade 2; 10.35 per cent, of Grade 3, and only 3.45 per cent, of Grade 4. Among our five living non-surgical patients were two who had papillary adenocarcinomas, two who had carcinomas in adenoma, and one who had a diffuse adenocarcinoma. In three of these cases the neoplasms were of Grade 2, and in two, of Grade 1.

In the surgical group of the 33 patients who died, only three (9.09 per cent) had papillary adenocarcinomas; 25 (75.76 per cent) had carcinomas in adenoma, and five (15.15 per cent) had diffuse adenocarcinomas. By grade of malignancy, 15.15 per cent of the neoplasms were of Grade 1; 54.54 per cent, of Grade 2; 9.09 per cent, of Grade 3, and 21.21 per cent, of Grade 4. Among the 46 patients who are known to be dead in the non-surgical group, biopsy of 23 of the tumors was obtained and the malignancy graded. In round numbers, 30 per cent had papillary adenocarcinomas; 22 per cent, carcinomas in adenoma; 30 per cent, diffuse adenocarcinomas, and 17 per cent, carcinomas resembling sarcoma. By grade of malignancy, 17 per cent of the growths were of Grade 1; 26 per cent, of Grade 2; 17 per cent, of Grade 3, and 39 per cent, of Grade 4. Again the tendency toward the higher grades of malignancy was well marked in the fatal cases.

CONCLUSIONS

Carcinoma of the thyroid gland is a highly fatal form of malignancy, most difficult to diagnose clinically and histologically. Due to the proximity of the gland to large blood vessels and lymphatic structures, widespread metastasis is common, usually terminating the picture.

Four main types of carcinoma are recognized histologically: (1) papillary adenocarcinoma; (2) adenocarcinoma in adenoma; (3) diffuse adenocarcinoma, and (4) spindle-cell carcinoma resembling sarcoma. The prognosis varies and the types are named in approximately ascending order of malignancy.

Treatment consists of operation only, irradiation only, or a combination of the two. Irradiation only is a poor policy unless the growth is so extensive as to be totally inoperable; then, with irradiation only, palliation usually can be secured, and even cure in the occasional case (10 per cent of our medical series). Surgery only is not justifiable, even if the carcinoma is entirely removed. The facts that most carcinomas of

the thyroid gland are of low-grade malignancy and that, in an appreciable percentage of cases in which operation cannot be performed, irradiation is followed by cure are evidence that these growths are sufficiently radiosensitive fully to warrant post-operative treatment. Because of the frequency with which carcinoma of the thyroid gland develops in a pre-existing nodular goiter, and the difficulty of distinguishing carcinomas in their early stages from benign tumors, surgical removal of all nodular goiters should be considered the treatment of choice, together with post-operative irradiation whenever carcinoma is found.

BIBLIOGRAPHY

(1) Balfour, D. C.: Cancer of the Thyroid Gland. Med. Rec., Nov. 16, 1918, CXIX, 846.

(2) Bowing, H. H.: Malignant Tumors of the Thyroid Gland Treated by Operation, Radium, and Roentgen Rays. Am. Jour. Roentgenol. and Rad. Ther., December, 1927, XVIII, 501-508.

(3) Craver, L. F.: Cancer of the Thyroid and its Present-day Treatment. Ann. Surg., December, 1925, LXXXII, 833-853.

(4) Graham, Allen: Malignant Epithelial Tumors of the Thyroid. Surg., Gynec. and Obst., December, 1924, XXXIX, 781-790.

(5) Herbst, W. P., Jr.: Malignant Tumors of the Thyroid. Ann. Surg., April, 1924, LXXIX, 488-494.

(6) Pemberton, J. deJ.: Malignant Disease of the Thyroid Gland: Clinical Consideration. Ann. Surg., March, 1928, LXXXVII, 369-377.

(7) Pfahler, G. E.: The Treatment of Carcinoma of the Thyroid. Am. Jour. Roentgenol., January, 1922, IX, 20-25.

(8) Portmann, U. V.: Radiation Therapy in Malignant Diseases of the Thyroid Gland. Jour. Am. Med. Assn., Oct. 1, 1927, LXXXIX, 1131-1135.

(9) Toland, C. G.: Carcinoma of the Thyroid. Surg., Gynec. and Obst., April, 1925, XL, 579-581.

(10) Wilson, L. B.: Malignant Tumors of the Thyroid. Ann. Surg., August, 1921, LXXIV, 129-184.

DISCUSSION

Dr. G. E. Pfahler (Philadelphia, Pa.): It has been my impression that carcinoma of the thyroid is more sensitive than the average carcinoma. That may, of course, be an impression obtained from relatively few cases; however, it has led me to recommend radiation therapy in all cases that can be diagnosed clinically as carcinoma.

As Dr. Fricke has said, the diagnosis is very difficult, both clinically and microscopically. Most of the cases I have treated were diagnosed at operation when sections were removed. Cases were found inoperable and we then treated them chiefly by means of roentgen rays. In a few cases, we inserted radium needles in the main tumor mass, which, I believe, is the proper procedure.

One of these cases had been operated upon three times before the patient came to me. Under radium treatment for recurrence, the patient remained symptom-free for about three years, then dying with metastasis to the spine.

In another case, the late Dr. John Deaver told me he removed most of the tumor, but he was quite positive he did not remove all. Although the patient remained symptom-free for 12 years, in the thirteenth year he developed general metastatic carcinoma in the lung. Therefore, we cannot conclude, even if we do arrest the primary disease, that we will not, at some later time, have metastasis to deal with, and we must keep these patients under observation for a long time.

I believe we are justified in recommending the surgical removal of adenomas when the patients consent. If they will not consent, we are justified in recommending radiation treatment.

About two years ago we reported 130 cases of adenoma associated with hyperparathyroidism, which we have treated. None of those cases, up to the present date, has developed carcinoma. That is a relatively small number, but still, in the ordinary percentage value, one or two of those should have developed a carcinoma.

If the roentgen rays will cure carcinoma, I believe we have a right to assume that they will probably prevent carcinoma cells from developing. Therefore, we need not assume that radiation treatment is contra-indicated merely because the patient has an adenoma. Since, however, adenoma is removed with relative ease from the thyroid gland, and this is probably the simplest way out of the trouble,

especially when there is no hyperthyroidism present, it seems to me that removal is a proper procedure to recommend.

When we treat these cases of carcinoma by irradiation, we must remember that we are dealing with carcinoma. It has been my principle, in all treatment of carcinoma, to carry radiation to the limit of the normal tissue tolerance. If we do that, many more of our patients will recover than if we try to give as little radiation as possible. I think often the failure in the treatment of carcinoma is due to too little radiation.

Dr. R. H. Stevens (Detroit, Mich.): I have not had much favorable experience in treating carcinoma of the thyroid. Practically all the cases I have had recommended to me for treatment already had metastasized in the lung, so we have not been able to accomplish very much. There is one case, however, which I would like to mention, a rather rare example, and on which I would like to have Dr. Fricke's opinion. I have not been able to get very much information about it.

A patient, about eighty years of age, developed a pathologic fracture of the clavicle. Upon roentgen examination, the appearance of the clavicle was found to be typical of a metastatic carcinoma. We also found similar lesions in the upper part of the humerus and the upper part of the radius and in the dorsal spine. This patient was apparently in perfect health. We were unable to find any evidence of carcinoma of the prostate or the thyroid. He continued to develop a spastic paralysis of the limbs and finally died from the involvement of the spinal cord.

At postmortem, we searched the thyroid very carefully, sectioning it, and were about to say it was perfectly healthy and normal, when, deep in the thyroid, we came upon a small growth the size of a man's thumb nail, which contained colloidal material. We examined the involved bones and found deposits of the same colloidal material. All of the other organs were perfectly healthy, there were no signs of carcinoma anywhere. There were no carcinoma cells found in the thyroid or bones. This has been described as "colloidal metastasis." Roentgentherapy was ineffectual.

I would like to ask whether you would classify that under the term "colloidal carcinoma," or what explanation you might have for it.

Dr. D. T. Quigley (Omaha, Neb.): Most of the cases of adenomatous thyroid with which I have dealt have been rather young. I would like to ask Dr. Fricke if he considers it probable that these carcinomatous changes will develop in a thyroid adenoma in younger women. Ought we to have the same fear of carcinoma developing in cases in which we see a good many adenomas?

Another type is rather common: the metastasizing tumor of the thyroid which, under the microscope, does not show carcinomatous change. In other words, it is a metastasizing adenoma of the thyroid which is classified by some pathologists as malignant and by others as non-malignant.

Personally I believe any tumor which has metastasized is malignant, but I would like to know Dr. Fricke's viewpoint. Would you, at Rochester, classify that as malignant or has this point been taken into consideration?

Dr. Fricke (closing): Our pathologic data referred to were noted by Dr. Broders and Dr. Bueermann. I wish we had them here to answer the questions.

I think that, in Dr. Stevens' case, metastasis had occurred from a carcinoma in an adenomatous thyroid. As I have mentioned, even pathologists differ on these sections. There are so many histologic pictures simulating carcinoma that the problem is very complex.

Regarding the question of resecting adenomatous goiter from patients about twenty years of age, of course carcinoma may occur in an adenoma at any age, but we are more apprehensive if patients are of the cancer age. The adenomas of persons forty years old or more would be the ones we should be the most anxious to resect.

CASE REPORTS AND NEW DEVICES

HYPERTROPHIC PYLORIC STENOSIS IN THE ADULT

WITH REPORT OF A CASE

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Hypertrophic pyloric stenosis in the adult as a cause of gastric obstruction has only recently obtained noticeable clinical recognition. Maier (7) noted the condition at autopsy; Maylard (8) directed attention to the importance of congenital stenosis of the pylorus in adults; more recent writers (2, 4, 10) have called attention to the surgical treatment, and Archer (1) and McClure (9) have lately contributed to knowledge of the roentgen aspects of the condition. The small number of cases described by various authors indicates the relative infrequency with which the condition is recognized.

PATHOLOGY

The essential pathology is a thickening of the musculature forming the pyloric sphincter, with resultant narrowing of the lumen. McClure (9) presents excellent illustrations of the gross and microscopic pathology.

ETIOLOGY

The etiology has not been definitely determined. Among the theories advanced are the following:

1. The persistence, through adult life, of a congenital hypertrophy of the pyloric muscle, insufficient to cause severe obstruction in infancy, but becoming aggravated in later years. Horton's (6) observation of the relative thickness of the pyloric muscle in the fifth and sixth months of fetal life is of interest.

2. Pirie's (11) theory is hyperadrenalism, resultant deficiency in pancreatic secretion, with insufficient neutralization of gastric juices, consequent prolonged pyloric closure, and an eventual occurrence of pyloric hypertrophy and stenosis. Elman and Rowlette (5) suggest that gastric acidity is regulated by the pylorus, rather than that acidity regulates pyloric function.

3. Hypertrophy due to persistent pylorospasm from nervousness or reflex causes (1, 9).

SYMPTOMATOLOGY AND DIAGNOSIS

The presence of a pyloric obstruction is to be suspected in all patients who give a history of epigastric pain relieved by vomiting long retained gastric contents. Among the conditions arising for differential consideration are: large esophageal diverticulum; malignancy or ulcer of the pylorus, with spasm; gastric syphilis or neurosyphilis with gastric crises; pylorospasm, without organic lesion; gastric or duodenal polypi; diverticulosis of the duodenum; duodenal ileus; chronic cholecystitis, with or without stones; pressure obstruction from pancreatic or other extrinsic tumors, and psychic vomiting.

Roentgenologic examination of the gastro-intestinal tract and gall bladder obviously offers the best means of differentiating these various conditions. The chief roentgenologic findings (1) are essentially:

1. A persistent and unchanging increase in the width of the pyloroduodenal interval, "due to an increase in extent of the pyloric ring."

2. The presence, in some cases, of associated spastic incisuræ several centimeters distant from the pylorus.

3. Failure of antispasmodics and fluoroscopic manipulation to alter the pyloric picture.

4. A narrow barium stream through the pylorus.

It is difficult, and at times impossible, to differentiate scirrhous carcinoma of the pylorus and a small ring ulcer with spasm from hypertrophic stenosis (1). The presence of an encircling adhesion about the pylorus may be a source of confusion.

In the advanced cases, the retention of barium beyond a five- or six-hour period (dependent on the type of meal used) will usually occur. The degree will afford a rather good index of the amount of stenosis, as will the extent of narrowing of the barium stream.

An additional roentgen finding, as in the case reported below, may lead to a suspicion of pyloric hypertrophy. Just prior to the sphincter, it was noted that the gastric rugæ were rather plainly marked. It was felt that hypertrophy of the rugæ might also be accompanied by hypertrophy of the musculature of the pylorus. Whether or not this observation is of any value will depend on its being noted in a large number of cases; at present it is merely a suggestion.

Since the nature of the gastric contents may vary so much in disease and in health, gastric analysis offers no dependable diagnostic aid in the presence of this lesion.

Particularly in those cases believed to have their origin in a congenital hypertrophy of the pyloric musculature, the history of attacks of epigastric pain and vomiting over a period of years, reaching back into childhood, is very important and suggestive.

TREATMENT

The treatment is surgical, the majority of writers advising pyloroplasty. Manual dilatation of the sphincter may afford relief, but this is usually only temporary. Gastro-enterostomy, which offers a solution, may be indicated.

The question of dietary following the surgical procedures is best determined by the type of operation employed and the patient's individual needs.

CASE REPORT

It is realized that the interval between the operation and this report (19 months) is rather short, but the nature of the existing pathology and the mechanical effect of the operation lead one to believe that relief will be permanent. The case is suspected of falling in the category of persistent congenital lesions.

A white woman, married, age 24 years, was referred for roentgen examination of the gastro-intestinal tract on Feb. 6, 1931, with a chief complaint of pain in the stomach, and vomiting.

The family and marital history were irrelevant. (Since this initial history-taking, the father has been found to have carcinoma of the prostate, with bone metastases.)

At the age of six weeks, the patient was "poisoned on milk," according to her mother, and suffered with severe attacks of colic and vomiting. These occurred at irregular intervals until the age of 12, when they subsided to some extent.

Childhood diseases included diphtheria and scarlet fever at 4 years, pneumonia at 6, and chicken pox and measles at 12.

The patient's health was better during the period from 12 to 18 years. There were only occasional attacks of indigestion, manifested by abdominal pain and vomiting. She was always thin and had never showed any marked gain in weight. While she was at boarding school, between the ages of 18 and 20, her health was good and there was only one severe attack of abdominal pain, but this was marked by prolonged vomiting. In 1926, at the age of 19, she married. At the time of examination there had been no pregnancies. Occasional attacks of nau-

Fig. 1. Note the widened pyloroduodenal interval, hypertrophy of the prepyloric rugæ, and the narrow barium stream through the pylorus.

Fig. 2. Eight-hour gastric retention.

sea and epigastric pain occurred during the next four years.

In 1930, about a year prior to roentgen-ray examination, the attacks of epigastric pain and nausea became more severe and frequent. Vomiting usually relieved the pain. These attacks continued for about three months, then they abated in frequency and severity, following treatment of constipation and the use of alkalis. On June 26, 1930, appendectomy was performed for an acute attack but the stomach was not explored. In January, 1931, the attacks of epigastric pain returned with renewed vigor and frequency, occurring as often as twice a week. There was some pain almost every night, but attacks might occur at any time within the 24 hours. About two weeks prior to examination, the writer saw the patient during one of these attacks. Nausea was severe but vomiting difficult. The pain was described as beginning under the left ribs anteriorly and migrating to the epigastrium. There was no palpable tumor, no rigidity, and no particular point of tenderness. The pulse was rapid and the temperature 98° Fahrenheit. Gastric lavage with soda water yielded oranges eaten nine hours previously. No food had been taken after the oranges.

Fig. 3. After gastro-enterostomy. Note that the pyloroduodenal interval remains widened.

The patient was relieved by the lavage. Roentgen examination of the gastro-intestinal tract was made on Feb. 6, 1931.

X-ray Examination.—The esophagus was normal. The stomach showed a wide pyloroduodenal interval, with hypertrophy of the rugæ just proximal to the pylorus, and a nine-hour retention of about 25 per cent of the meal. Hypermotility of the small bowel and a spastic type of colon, with no undue stasis, were noted. The gall bladder was

seen to be normal by oral cholecystography. There was no evidence of pulmonary pathology.

It was thought that the gastric retention was functional and due to a pylorospasm. The former appendectomy and the normal appearance of the gall bladder on the cholecystogram practically eliminated these two organs as sources of reflex spasm.

Gastric Analysis.—Feb. 9, 1931. Total acidity 47; free hydrochloric acid 39.5.

Blood Wassermann and Kahn tests were negative, as was the urinalysis. Basal metabolic rate, —12.

The patient was placed on medical treatment, including belladonna in ascending doses, and a smooth and liquid diet. During the following two months, the constipation was somewhat relieved, but the attacks of epigastric pain persisted, although less in severity and frequency. Substitution of full liquid diet for the low-residue diet failed to prevent the attacks.

At the end of the two months, roentgen examination was repeated. The findings were essentially the same, with about 20 per cent gastric retention at eight hours. The appearance of the pylorus was unaltered. Atropine (1/75 gr. hypodermically) failed to affect the pyloric findings or to decrease materially the gastric retention. In view of the absence of a demonstrable ulcer, the appearance of the pylorus, the gastric retention, and the long history of colic and vomiting, pyloric muscle hypertrophy was suspected and exploration advised. The second consideration was encircling pyloric adhesions.

On April 24, 1931, operation disclosed marked thickening of the pyloric muscle, with narrowing of the lumen. There was no evidence of ulcer or neoplasm. There were a few adhesions about the second portion of the duodenum, judged insufficient to cause obstruction. Posterior gastro-enterostomy was performed and recovery was uneventful.

In August, 1931, there was some pain over the left abdomen, with nausea and vomiting, gaseous distention, and tenderness over the descending colon. This was relieved by medical treatment. There have been no further attacks of nausea, vomiting, or epigastric pain. The general health is good.

Roentgen examination on Jan. 12, 1932, disclosed a normally functioning gastro-enterostomy, with the stomach empty in about three-and-a-half-hours, but the appearance of the pylorus remained unchanged.

In November, 1932, the patient gave birth to a child, successfully going through a low forceps delivery. The infant weighed 9.5 pounds.

SUMMARY

1. Attention is called to the clinical significance of hypertrophic stenosis of the pylorus in adults.

2. The pathology, etiology, symptomatology, diagnosis, and treatment are briefly reviewed, with special reference to the roentgen findings.

3. A case is reported showing the clinical features, roentgen findings, and surgical pathology of hypertrophic stenosis of the pylorus, with operative relief of symptoms.

BIBLIOGRAPHY

(1) Archer, Vincent W.: Hypertrophic Pyloric Stenosis in Adults; Roentgen Aspects. Am. Jour. Roentgenol. and Rad. Ther., May, 1930, XXIII, 510-515.

(2) Bastianelli, R.: Pylorus Spasm and Its Surgical Treatment. Ann. Surg., January, 1925, LXXXI, 45-51.

(3) Chaney, Ralph H.: Congenital Pyloric Stenosis in Adult Life. Jour. Med. Assn. Georgia, February, 1928, XVII, 57-62.

(4) Crohn, B. B.: Congenital Pyloric Stenosis in Adult Life. Jour. Am. Med. Assn., Jan. 21, 1928, XC, 197-199.

(5) Elman, Robert, and Rowlette, A. P.: The Rôle of the Pyloric Sphincter in the Behavior of Gastric Acidity. Arch. Surg., March, 1931, XXII, 426-437.

(6) Horton, Bayard T.: Pyloric Block, with Special Reference to the Musculature, Myenteric Plexus, and Lymphatic Vessels. Arch. Surg., March, 1931, XXII, 438-462.

(7) Maier, R.: Beitrage sur angebornen pylorus Stenosis. Virch. Arch. f. path. Anat., 1885, CII, 413 (quoted by Morton).

(8) MAYLARD, A. E.: Congenital Narrowness of the Pyloric Orifice a Cause of Chronic Gastric Disease in the Adult. Brit. Med. Jour., 1904, I, 416; also 1920, I, 626 (quoted by Morton).
(9) MCCLURE, C. C.: Hypertrophy of the Pyloric Muscle in Adults. Surg., Gynec. and Obst., May, 1931, LII, 945-952.
(10) MORTON, C. B.: Hypertonicity with Hypertrophy of the Pylorus in Adults; Surgical Aspects. Arch. Surg., March, 1930, XX, 508-514.
(11) PIRIE: Quoted by Chaney.

USEFUL PROCEDURES IN RADIOLOGIC PRACTICE

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Abstract.—Many diagnostic and therapeutic radiologic procedures, unquestionably definite improvements over the current routine technic, are not reported on account of their apparent elementary simplicity. We offer a few suggestions which may prove of service and stimulate others to contribute helpful suggestions.

(1) In lieu of the customary sheet lead, employed in shielding one-half of the film holder during a roentgenographic exposure, one may place sheet lead (7 in. × 17 in.), of identical thickness (3/32 in.), between two pieces of relatively thin veneered wood, fastened together, preferably with short rivets. The arrangement possesses the following advantages: *(a)* A straight edge which gives the completed film a clean-cut appearance; *(b)* a shielding for the patient, when one is employing the four-port technic of deep roentgentherapy (since the lead is insulated by the apposing wooden surfaces, troublesome static discharge is entirely eliminated); *(c)* neatness of appearance.

(2) Occasionally a complete set of dental films is discarded because they are lacking in density and contrast, or the reverse. To obviate this, the duplicate dental films are separately mounted upon two dental film hangers, one set being developed one minute longer and the other set one minute less than the standard developing time. Obviously, one set of films will be slightly lighter and the other slightly darker than if the standard developing time had been used. One of the sets is almost certain to meet with approval.

(3) In using radiographic cones, cylinders, and diaphragms, the radiographer does not always take into consideration that it is not merely the diameter of the cone that increases the quality of the roentgenogram, but, rather, the size of the port of entry of the primary beam. A dental cone will present its maximum effect only when it is positioned as close to the object as is feasible. The more relatively distant the skin-target distance, the larger will be the exposed area, and consequently the larger will be the port of entry. If the distance from the target to the film is such that the size of the port of entry is 5 in. in diameter, the small dental cone will be of no more value from the standpoint of increasing the contrast of the film than would be a larger cone with a diameter at the open end of 5 in. in direct contact with the part. A flexible rule for the operator in the employment of radiographic cones is as follows: The smaller the exposed area, equivalent to the port of entry, the greater is the resulting contrast, provided this restriction is effected by the cone. However, when employing cones at variable distances, particularly when exceeding 25-in. film-target distance, it is often problematical whether or not the primary beam is effectively utilized, and, also, whether the film is being properly covered by the x-radiation. This uncertainty is experienced particularly when the filter is one or two millimeters of aluminum, the endeavor being to minimize the possibility of radiodermatitis as a result of excessive exposure, by filtering out the deleterious and undesirable soft x-radiation. Furthermore, it is deemed advisable never to make ex-

posures of the head without the insertion of at least 1 mm. of aluminum as a filter. That this procedure is extremely important from a medico-legal standpoint is incontrovertible; but the inherent disadvantages of cutting off the localizing cone of light when the aluminum filter is in position often tempt the operator to omit the filter, thereby entailing the risk of omitting it in routine roentgenography. It must be conceded that one is unable to differentiate a film taken with 1 mm. Al from one taken without a filter.

(4) Since a single thickness of ordinary sheet window glass has the same approximate absorption coefficient and relatively equivalent filtration value as 1 mm. of aluminum, it is patent that this can profitably be employed in lieu of the aluminum filter, permitting of filament illumination for focusing and localizing purposes. If the equivalent filtration value of 2 mm. of aluminum is desired, two thicknesses of ordinary window glass are employed. An added convenience which enables one to obtain the exact center of the primary beam is a small round piece of black paper pasted in the exact center of the glass filter. This procedure outlines the field of radiation with a central unilluminated area which corresponds, for practical purposes, to the center of the primary beam, which can then accordingly be directed to the desired position. This procedure is helped considerably by slightly darkening the radiographic room. The glass filter should be of sufficiently small size to permit of a slight amount of play when in position. It is desirable to further reinforce all sides of the filter with thin strips of adhesive plaster along the edges, a safeguard which will aid in preventing the inopportune breaking of the glass filter.

(5) It is true that the average technician uses a cone of much larger diameter than is necessary to cover the desired area, thus defeating the very purpose of the cone. By utilizing the beam of light, this error is corrected by merely viewing the actual area covered by the cone and then substituting a cone of proper size. In stereoradiography, the cone of light is a useful adjunct in the determination of the proper tilt of the cone. Again, this is also desirable in radiography of the chest, the infrequently used and neglected cone being an important factor in increasing the contrast of the film.

(6) Many difficult angles and unusual views in roentgenography often can be obtained only by the judicious use of a shock-proof dental unit, either oil-immersed or of another type of insulation. The extremely fine focus of a dental x-ray tube lends itself admirably to the obtaining of the maximum in minute detail such as is wellnigh mandatory for the proper interpretation of pathologic bony structure. An extraordinary view of the head of the humerus, acromion process, and outer end of the clavicle is obtained by focusing the dental cone directly cephalad in the axillary pit, with the cassette resting upon the shoulder, supported by the patient's other arm. Frequently, fractures not to be detected in the ordinary projections, especially in the region of the anatomical neck of the humerus, were readily disclosed by this method.

(7) True lateral projections of fractures about the head and neck of the femur are obtained with the aid of a shock-proof dental unit. This is accomplished by placing the patient in Arcelin's position, *i.e.*, the dorsal decubitus with the thigh flexed 90° upon the normal hip. The film is then placed on the outer border of the hip to be examined, and held securely in position, either by the patient or a sand bag. The dental cone is focused laterad and slightly cephalad on the medial aspect of the affected hip, and the exposure made.

Another excellent lateral view of the hip is procured by reversing the above procedure. The cassette is pushed cephalad, between the thighs, into the perineum, with the dental cone focused caudad and mesiad,

from the outer aspect of the hip to be examined. This is comparable to the Costes' position.

(8) In suspected fracture of the nasal bone, a lateral view of the region is made by placing a regular or large size dental film in direct apposition to the outer side of the nasal bone region, and focusing the dental cone in a directly transverse line from the opposite side. This eliminates the undesirable magnified distortion present in the routine lateral projections of this region, due to the great distance of the film from the nasal bone.

(9) There are sundry uses for dental films other than in roentgenography of the teeth, such as their application in taking lateral views of the phalanges. The dental packet is deftly inserted between the phalanx to be examined and the adjacent one, focusing the x-ray tube upon the outer side of the former. Anteroposterior views of these digits are also made upon dental films. Special limiting views of the carpal bones upon dental films, in suspected pathologic conditions, are excellent for demonstrating minute detail. In this respect, however, a word of warning will not go amiss: never radiograph any small confined area without initially taking a larger view of the region in question, in order to make certain whether or not other fractures or, possibly, pathologic conditions, exist, of which the patient does not complain. These unsuspected conditions may be completely overlooked if they are not included in the larger field of examination.

(10) The use of the shock-proof dental unit in conjunction with the Altschul technic offers an ingenious method of radiographing the temporo-mandibular articulation. In this examination, the patient lies in the true lateral decubitus, with the temporo-mandibular joint positioned in the center of an 8×10 cassette. The dental cone is positioned close over the base of the coronoid process of the opposite side, which enables one to haze out, as it were, the detail of the normal side by the phenomenon of magnified distortion. The central beam is then directed toward the temporo-mandibular articulation under observation, tilting the cone 25° caudocranially and 20° fronto-occipitally.

(11) An unusual longitudinal view of the patella is procured by flexing the affected knee as acutely as possible, with the patient himself holding an 8×10 cassette in position upon the anterior surface of the distal end of the femur just beyond the inferior border of the patella. The central ray of the shock-proof or other unit is projected cephalad and dorsad, toward the central portion of the film. It is to be noted that the less the degree of flexion obtained, the greater the film-target distance. This projection presents an admirable view of the anterior and posterior surfaces of the patella, in a longitudinal perspective, not demonstrable by any other method.

(12) Mastoid tip projections are more readily taken by the dental unit than by the routine technic. While the patient sits in the dental chair the cone can be positioned dexterously.

(13) It undoubtedly has been the experience of all who employ the oral method of cholecystography that occasionally, in the administration of the dye, the patient experiences an untoward reaction, manifesting itself in a pronounced diarrhea. This, of course, renders the test valueless, inasmuch as the dye is insufficiently absorbed, during its hurried passage through the alimentary tract, to visualize a normally functioning gall bladder. Not only is this an undesirable reaction from the patient's standpoint, but if he is inadvertently not questioned and does not volunteer information, the diarrhea may be unknown and an entirely misleading diagnosis of non-functioning gall bladder may be made, and unwarranted operative procedure may be instituted. This idiosyncrasy to the gall-bladder dye can be

entirely eliminated by the simultaneous ingestion of from one to four fluid drachms of tincturæ opii camphoratæ, with the repeated cholecystographic medium.

(14) The fact that motion, both physiological and involuntary, and accidental or voluntary, plays such an important rôle in the final quality of a film, emphasizes the increasing necessity for higher capacity equipment and added technical skill. One may acquire ability to judge accurately how long the patient or part can remain or be maintained motionless; to so change the physical factors involved as to secure radiographs of the highest quality in the allowable exposure time and to effectively immobilize the part. The inherent difficulty of eliminating the involuntary motion caused by respiration is unquestionably the most persistent cause of improper visualization in cholelithiasis. The customary instructions cursorily given the patient—to take a deep breath and hold it—are too frequently misunderstood, the patient slowly exhaling during the exposure, and causing slight motion of the diaphragm and viscera, with consequent blurring and indistinct visualization of the gallstones or gall bladder. When dealing with patients who do not understand the language spoken, one should employ the following technic. A temporary state of apnea is created in the patient, immediately before the exposure is to be made, by telling him to take a dozen or more deep breaths, after which a nose-pincher device, such as is commonly employed in basal metabolic rate estimations, is used as an added precaution. He is then told to keep the lips tightly closed, whereupon the exposure is made. This procedure eliminates all breathing, conscious or unconscious. It is wellnigh impossible for an apprehensive or unintelligent person to hold his breath upon merely being told to do so, without supplementary precautions having been taken.

This same procedure is practised in serial-ography of the stomach, with the patient pinching his own nose with his hand, in lieu of the mechanical contrivance. This procedure, when once routinely established, is well worth the added time necessary for its proper performance.

(15) There are many conveniences and various time-saving devices in the realm of radiotherapy, such as the routine use of a synergistic combination of a mild hypnotic and a sedative. This is an invaluable prophylactic procedure in allaying much of the nausea and vomiting, lassitude and depression, familiarly encountered in radiotherapy, and especially marked in deep roentgentherapy. A capsule consisting of one grain of phenobarbital and ten grains of sodium bromide, administered one hour before irradiating the patient, is quite effective. Post-irradiation therapy consists of further neutralization of the untoward effects by the expeditious use of four drachms of glucose and one drachm of an alkali, either sodium bicarbonate or, preferably, calcium gluconate, in a glassful of orange juice as an excipient. It is to be stressed that the beneficial effects depend upon the immediate ingestion of the mixture after irradiation, not allowing the patient to procrastinate until the untoward effects make their appearance; after they do, this procedure is much less efficacious.

(16) The unpardonable sin in roentgentherapy is the neglectful omission of a filter. It is an excellent rule to train the assisting technician always to recheck the amount of filtration, prior to irradiating the patient. After the completion of a treatment, always replace the maximum amount of filtration in position. Further precaution which may be taken to prevent omission of a filter is to so modify the filters that they are readily visible from the control room. This may be done by riveting or soldering an aluminum or copper tab to the respective filters, the tab to be freely movable, *i.e.*, hinged. The tab on the aluminum filter is painted

white, with large black figures, "1" meaning "1 mm. of aluminum," *et cetera.* The tabs are marked on both sides so that, irrespective of which side of the filter is inserted in position, the number designating the filtration faces the observer. An identical procedure is followed for the copper filters with the exception that the tabs are painted red, with large white figures, such as "½" for 0.5 mm. of copper, "¼" for 0.25 mm. of copper, *et cetera.* The tabs are fastened upon the filters in such a manner that, when two or more filters are employed concurrently, they are so spaced as to permit all the numbers being read. The total combined filtration value can be readily determined. For example: red tabs marked "½" and "¼" and white tabs marked "1" and "2," indicate a total of .75 mm. of copper plus 3 mm. of aluminum filtration.

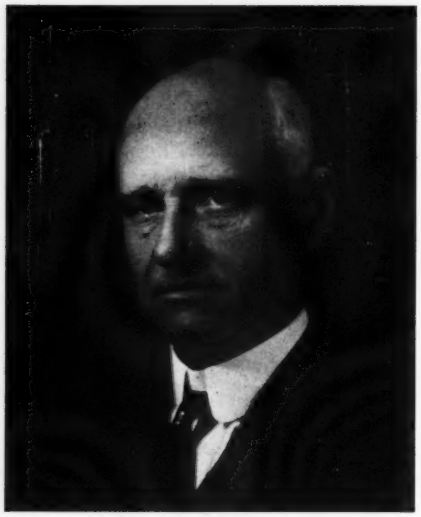
(17) Much annoyance can be avoided if the outlines of areas of irradiation are initially painted on the skin with a semi-permanent stain of the following composition: Equal parts of an aqueous sol. of gentian violet and a 50 per cent sol. of silver nitrate mixed together. The gentian violet readily stains the skin at the first application, to properly delimit the fields. As the treatment progresses, the gentian violet stain becomes fainter and eventually completely wears off. However, the silver nitrate stain has penetrated the epidermis and is discolored, due to the action of the light upon it, and thus the areas are well defined even after the lapse of considerable time. This procedure has been found far more valuable and effective than any other single stain, including mercurochrome and methyl violet.

(18) Probably the most nervous and apprehensive patients are those cases of hyperthyroidism undergoing x-radiation of the thyroid gland. This excitability is especially marked and aggravated when the face is covered with the protective leaded rubber sheet, and particularly so at the first séance. Unquestionably, much of the unwarranted fear could be allayed if the patient were permitted to observe the proceedings. This is effected by placing an ordinary protective face mask equipped with leaded glass lenses, such as is commonly employed by the roentgenologist in fluoroscopy, upon the face of the patient, and adjusting the leaded rubber extending below the chin to suit.

(19) The roentgentherapy of many benign and malignant skin lesions, especially basal-cell carcinomas about the face, can be greatly facilitated by the following device, designated to make two pieces of protective material serve for an unlimited number of treatments. The ordinary protective sheet lead or leaded rubber is cut to conform to a 10×15 cm. size. Then, upon this rectangle, two rows of apertures of increasing diameter are made, spaced 1.5 cm. apart for the smaller openings and 2.5 cm. for the larger apertures. Their shapes will be noted later. In a separate piece of sheet lead or leaded rubber, 15×15 cm., a centrally placed circular opening is cut, in diameter slightly larger than the greatest diameter of the largest graded opening in the first piece and yet sufficiently small to permit the second piece to cover the adjacent openings when the second piece is placed over the first. In practice, the aperture of a size to sufficiently expose the lesion, inclusive of a slight margin of surrounding healthy tissue, is chosen by fitting the gradated openings over the lesion until the opening of proper size is determined. Then the aperture in the second piece of sheet lead or leaded rubber is placed over this opening, completely protecting the adjacent skin from x-radiation by covering the undesired openings. In the first piece, various shapes and sizes of openings, such as elliptical, comma-shaped, etc., are profitably made for the treatment of irregularly shaped areas. By properly combining the above shapes and sizes, lesions of any description can be successfully dealt with. In addition,

these shields may be valuable in the localization of the lesion, when employing Doane's bipolar method of electrocoagulation. This method can be used either prior to, or without, coincident x-radiation. The shield acts as the indifferent electrode, and the active electrode, the coagulating needle, is placed within this area; after electrocoagulating the lesion, further x-radiation may be instituted without disturbing the lead shield over the area being treated.

In conclusion, it is our purpose in this presentation of radiologic "shop notes," to advance radiological technic. We do not wish to assume credit for the originality of all of the procedures herein offered.



The late JOHN F. HERRICK, M.D.

J. F. HERRICK, M.D., SUMMONED BY DEATH

Dr. J. F. Herrick, 69 years old, prominent radiologist, died after a long illness (lymphatic leukemia) on February 23, at St. Joseph's Hospital, Ottumwa, Iowa.

We all remember John Herrick as a pioneer radiologist, and one of the first to help organize the Western Roentgen Society, now known as the Radiological Society of North America. His interest in this Society was strong and continuous: he was ever ready to help in its progress and advancement. When the occasion demanded it he did not mince words in expressing approval or disapproval when he thought such a course was for the Society's good. He held various offices of trust in the Radiological Society in the most efficient, courageous, and impartial manner.

His many contributions to the science of radiology are too numerous to mention, but suffice it to say that the radiological profession of this country looked upon the contributions of John Herrick as being representative of the modern progress of radiology —illuminating, interesting, and educational.

John Herrick's activities were numerous. Besides enjoying a large, lucrative practice in radiology, he found time to engage in many civic enterprises, being looked upon by the people of his town as a leader upon whom they could depend. He was a devout man. He was close to his church. On February 4, when at High Mass in the chapel of St. Joseph's Hospital, where he died, he received a special blessing, communicated over the new direct system which has been set up from the Vatican City for the American continent.

He held a splendid war record, serving overseas for a long period as Major connected with Base Hospital No. 32 of Indianapolis, Indiana.

The members of organized radiology will miss their friend and co-worker John Herrick. The annual meetings of this Society will never be the same with him absent. He will be missed by all, particularly by the younger members of the profession whom he was always ready to encourage and help. We shall treasure his memory as one of our most precious recollections.

EDITORIAL

LEON J. MENVILLE, M.D. . . . *Editor*
BUNDY ALLEN, M.D. . . *Associate Editor*

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By neglecting to use radium in its appropriate fields, one often does not simply turn to surgery as a suitable and equally effective alternative, but does actually condemn patients to unnecessary suffering, invalidism, and even to death, who might have been saved by the more effective remedy.

HOWARD A. KELLY, A.B., M.D.,
F.A.C.S., LL.D.

THE AMERICAN CONGRESS OF RADIOLOGY

EDITORIAL BY THE PRESIDENT OF THE CONGRESS

The first American Congress of Radiology will be held at Chicago, September 25 to 30, 1933, at a time when the Century of Progress Exposition shall be at its best. There seems to be some lack of complete understanding on the part of a few members of the Radiological Society of North America and other societies directly interested as to the real purpose of this Congress. It will be an entirely new venture for American radiologists, but with every promise of complete success, and a few words by way of explanation seem fitting for the benefit of those who do not yet realize the real aims and objects.

The idea had its inception in the minds of a few radiologists soon after the first announcements were made that a Century of Progress Exposition was to be held in Chicago in 1933. These men believed that the interests of radiology as a medical specialty could be advanced by holding a combined meeting of all of our American radiological bodies as a unit in conjunction with the Exposition. The four national societies, namely, the Radiological Society of North America, the American Roentgen Ray Society, the American College of Radiology, and the American Radium Society, appointed representatives to formulate plans for such a Congress. These four societies are, therefore, the sponsors for the Congress, and all radiological societies of North and South America will receive invitations for their members to attend.

The organization of the Congress is vested in an Executive Council composed of Benjamin H. Orndoff, M.D., *Chairman;* Edward L. Jenkinson, M.D., *Secretary;* Henry Schmitz, M.D., *Treasurer;* James T. Case, M.D., Maximilian J. Hubeny, M.D., Byron H. Jackson, M.D., B. R. Kirklin, M.D., Leon J. Menville, M.D., Lawrence Reynolds, M.D., John T. Murphy, M.D., George E. Pfahler, M.D., and Albert Soiland, M.D. The Council elected Henry K. Pancoast, M.D., as President of the Congress and appointed as Vice-presidents the four Presidents of the sponsoring societies—Byron H. Jackson, M.D., John T. Murphy, M.D., Albert Soiland, M.D., and Rollin H. Stevens, M.D. These men will preside at appropriate sessions.

Only members of the Council will act as chairmen of the ten standing committees. Every effort has been made to ensure fair representation. For example, the editors of the two journals will serve as co-chairmen of the Committee on Publication, and Dr. Pfahler, Chairman of the Committee on Scientific Program, will have as his coworkers the secretaries of the purely scien-

tific societies and the president or president-elect of each of the societies whose duty it would be to work out the program for his respective society. The chairman of this important committee is ready to request volunteers on the scientific program.

The scientific sessions of the Congress will be held in the Palmer House, Chicago, September 25 to 30, 1933. The scientific and commercial exhibits will be conveniently located in the same hotel.

It is planned to hold only morning sessions with two sections, one on diagnosis and one on therapy, except that on the first morning there will be but one combined session. Probably two evenings will be devoted to the Convocation of the Radiological Society and awards, conducted by the officers of the Society, the Janeway Lecture under the auspices of the American Radium Society, the Caldwell Lecture under the patronage of the American Roentgen Ray Society, and the Convocation of the American College of Radiology. Two of these events will be held on each of the two evenings. In this way ample opportunity will be provided for all members and guests to visit the Exposition during the afternoons and the remaining evenings. These will indeed be opportunities of a lifetime.

The permanent headquarters and business office of the Executive Council and Administration are at 2561 North Clark Street, Chicago, to which any inquiries may be directed.

This Congress is designated as a meeting wholly in the interests of radiology as a specialty in medicine, in its relations with other branches of this profession and the science of physics, as a means of collective research, and as an exceptional opportunity to create in the public mind a proper attitude towards a specialty which has for its object the benefit of humanity. It is sponsored by four great Societies, each of which has had and will continue to have a worthy purpose in its existence, but has realized the wisdom of working together for a common interest.

HENRY K. PANCOAST, M.D.
President of Congress.

AMERICAN CONGRESS OF RADIOLOGY

COMMITTEE ON SCIENTIFIC PROGRAM

On January 28, 1933, a meeting of the Scientific Program Committee was held in Philadelphia at which the following were present:

Henry K. Pancoast, M.D., Eugene Pendergrass, M.D., John T. Murphy, M.D., Byron H. Jackson, M.D., Leopold Jaches, M.D., William A. Evans, M.D., and George E. Pfahler, M.D.

It was decided that we should hold two evening sessions.

It was decided to hold no banquet and no dance. This was done for the sake of economy of time, money, and energy.

The first evening session shall be on Wednesday, Sept. 27, at 8:30 P.M. sharp, at which time there will be a convocation of the American College of Radiology, and a brief address by the President. It will be conducted by the officers of the American College of Radiology, who will, in turn, introduce the officers of the American Roentgen Ray Society, who will officiate at the Caldwell Lecture.

On Friday, Sept. 29, at 8:30 P.M., there will be a convocation of the Radiological Society of North America, and an award of medals and honors, conducted by the officers of the Radiological Society of North America, who will, in turn, introduce the officers of the American Radium Society for the special purpose of conducting the Janeway Lecture by Professor James Ewing.

It was decided to request Dr. Orndoff, Chairman of the Executive Council, to introduce the speakers at the opening session of the Congress, until Dr. Pancoast, the

President of the organization, has been introduced, after which he will conduct the proceedings.

It was decided to divide the scientific sessions into three approximately equal divisions, and request the officers of the American Roentgen Ray Society, the Radiological Society of North America, and the American Radium Society to conduct the scientific sessions. At the evening sessions, Dr. Pancoast shall introduce the President and officers of the Societies who open the meeting.

It was decided to omit all discussion. This will permit some additional papers, and, we believe, permit us to run the meeting more definitely on schedule. This will of necessity eliminate the names of men who previously have been listed for discussion, and who for the most part are not members of the radiological societies, and will permit those who are members, and who were scheduled for discussions, to prepare papers.

It was decided to request many of the speakers to abstract their papers to five or ten minutes, and some of them to permit their papers to be read by title.

It was ordered that every author must submit his paper to the Secretary at the time of presentation so that it can properly be published in one of the two Journals, and, in order that this be understood, a notice to this effect shall be sent from the Executive Secretary's office after the program is completed to each author or participant. This will permit us to omit the cost of stenographers. A stenographer will be needed only for the executive sessions of the various Societies, which executive sessions will be arranged for, and the expense thereof borne directly by the Societies.

It is requested that the Editors of the two Journals give some notice to this meeting in every issue of the journals until the time of the Congress. In the next issue of these Journals, it is hoped that the request for volunteers for the program will be published. For the subsequent issue, it is requested that Dr. Pancoast, President of the Congress, write a brief statement of the aim and reasons for the Congress. In the succeeding issue, it is likely that we will be able to publish the preliminary program.

The entire program was then reviewed to date, and rearranged on the basis of omitting discussions, and some additional men named, who are to be specially invited.

G. E. PFAHLER, M.D., *Chairman.*

ANNOUNCEMENTS

CLEVELAND RADIOLOGICAL SOCIETY

R. J. May, M.D., is President of the Cleveland Radiological Society and M. A. Thomas, M.D., is Secretary-Treasurer. The meetings are held on the fourth Monday of each month at the Cleveland Chamber of Commerce at 6:30 P.M., from October to April, inclusive.

FLORIDA RADIOLOGICAL SOCIETY

W. McL. Shaw, M.D., of Jacksonville, Florida, Secretary-Treasurer of the Florida Radiological Society, wishes the publication of notice to the effect that the next meeting of that Society will be held in Hollywood, Florida, on May 1.

MINNESOTA RADIOLOGICAL SOCIETY

The Winter Meeting of the Minnesota Radiological Society was held at the Nicollet Hotel, in Minneapolis, on Saturday, February 18, 1933, at 2:00 P. M. The following program was presented:

1. Pre-operative Diagnosis of Malignancy of the Liver with Thorotrast.

LESTER G. ERICKSEN, M.D., Minneapolis.

2. The Physical Basis of Chest Radiography (Work of R. G. Wilsey) and the Ruggles Cine-cardiographic Film. ROBERT G. MORRISON, Minneapolis.
3. A Simplified Technic for Roentgenography of the Optic Canals. JOHN D. CAMP, M.D., and CESARE GIANTURCO, M.D., Rochester.
4. Atypical Findings in Bone Lesions. CHARLES G. SUTHERLAND, M.D., Rochester.
5. Roentgenologic Study of Bone Changes Accompanying Neurofibroma of the Spinal Cord and Associated Nerves. JOHN D. CAMP, M.D., Rochester. Discussion by W. A. O'BRIEN, M.D., Minneapolis.
6. Case Reports from the University Hospital:
   (A) Demonstration of Methylene Blue Method for Calibrating Roentgen-ray Dosage. W. K. STENSTROM, PH.D.
   (B) Achondroplasia, Advanced Ossification, Vertebral Osteochondritis. JOHN B. ENEBOE, M.D.
   (C) Carcinoma of Breast, Skeletal Metastases, Response to Radiation. C. O. HANSEN, M.D.
   (D) Carcinoma of the Skin: Response to Radiation. FREDERICK B. EXNER, M.D.
   (E) Simulants of Mediastinal Masses. LEO G. RIGLER, M.D.

The Society was honored by the presence of Dean RICHARD E. SCAMMON, PH.D., of the University of Minnesota Medical School, who delivered an illuminating and stimulating address on "The Contributions of Radiology to the Study of Growth."

At the business meeting a resolution was adopted endorsing the principles of the Code of Ethics of the Philadelphia Roentgen Ray Society.

The next meeting of the Society will be held in Rochester, Minn., May 22, 1933.

SUPPLEMENTAL LIST OF PARTICIPANTS IN THE SCIENTIFIC EXHIBIT AT THE ANNUAL MEETING[1]

F. F. BORZELL, M.D., Frankford Hospital, Philadelphia, "Erythroblastic Anemia Contrasted with Sickle-cell Anemia and Severe Secondary Anemia."

ROBERT B. TAFT., M.D., Charleston, S. C., "Ancient Egyptian Mummy: A Radiographic Study."

MAURICE LENZ, M.D., Presbyterian and Montefiore Hospitals, New York City, "Difficulties in Radiotherapy of Epithelioma of Head and Neck."

CARLETON B. PEIRCE, M.D., University of Michigan, Ann Arbor, "The Superior Mediastinal Spaces."

HAYES E. MARTIN, M.D., Memorial Hospital, New York City, "Cancer of the Lip, Tongue, and Cheek."

A. W. ERSKINE, M.D., and C. L. GILLIES, M.D., 326 Higley Building, Cedar Rapids, Iowa, "Injuries of the Wrist."

HENRY K. TAYLOR, M.D., Sea View Hospital, New York City, "Pulmonary Tuberculosis: A New Clinical Classification."

W. G. HERRMAN, M.D., Monmouth Memorial Hospital, Long Branch; Fitkin Memorial Hospital, Asbury Park, N. J., "Fusospirochetal Infection of the Lung."

ALFRED F. HOCKER, M.D., Memorial Hospital, New York City, "Roentgen Visualization of the Parotid Gland."

B. R. KIRKLIN, M.D., Mayo Foundation for Medical Education and Research, Rochester, Minn., "Papilloma of the Gall Bladder."

VOLUME XX TO BE INDEXED

To give our readers the most service possible, pending the completion of the monumental Subject Index covering the publica-

[1]These additional names were received by the Editor after publication of the January issue. They are to be considered as supplementing the exhibitors as named on page 46.

tions of the Society since 1918, the Editor announces that a Subject Index of the present volume is in preparation, to be included in the June issue.

EDITORIAL STAFF

The omission of the names of members of the Editorial Staff from recent issues does not mean that RADIOLOGY does not look to them for advice and co-operation as in the past; the omission has been decided upon by joint deliberation of the Executive and Publication committees, solely as a measure to make more space available for the publication of papers. Owing to the reduced size of RADIOLOGY, all members of the Editorial Staff in attendance acceded to the omission with the above-named object in view. It is the hope presently to resume the printing in each issue of the names of the Staff, but for the present, they have agreed to this economy.

BOOK REVIEWS

LE TERRAIN CANCÉREUX ET CANCÉRISABLE. By RENÉ REDING, Directeur de la Foundation Yvonne Boël Adjoint à la Clinique Chirurgicale Universitaire de l'Hôpital Saint-Jean. From Foundation Yvonne Boël (Hôpital Brugman) and Laboratoire de Cancérologie de l'Hôpital d'Ougrée-Marihaye. Paris, Masson et Cie., 1932. Paper, pp. 389, 17 figures. Price 50 francs.

The study of the biologic phases of cancer and carcinogenesis is growing steadily in importance, especially since the trend of thought has been that cancer cells grow better in an alkaline medium and that their growth is retarded or prevented when the medium is acid. In this book, Reding summarizes some extensive research work done by himself and his late chief, Professor A. Slosse. In the first portion, he submits proof of the existence of and of the pathologic importance of a cancerous and cancerizable *milieu*. In the second portion, there is a detailed discussion of the physiology and metabolism of cancer tissue. In the third part, there are some practical considerations, and in the fourth portion there is a complete description of the apparatus and the technic employed in the study. The author has carried out extensive studies on the hydrogen-ion concentration both from a physiochemical and a clinical point of view and feels, as a result of his experience, that these studies are of both a diagnostic and a prognostic significance. In this connection it is interesting to mention that in those cases in which roentgentherapy is to be beneficial the pH drops toward the acid values.

Such a study as the author's on hydrogen-ion concentration, supplemented by determinations of calcium-potassium balance, may open an interesting phase of the study of the inheritability of cancer; and, even though it is too soon to make positive statements or draw definite conclusions about the value of the author's book, it nevertheless deserves serious consideration by all who have an interest in the biology of cancer.

PRÉCIS DE CANCÉROLOGIE. By J. DUCUING, Professor Faculty of Medicine, Surgeon-in-chief of the Hospitals and Director of the Cancer Center of Toulouse, France. A cloth-bound volume of 1,259 pages, with 516 illustrations. Published by Masson et Cie., Paris, 1932. Price, 140 francs.

Intended as a brief summary of the entire subject of cancer from every point of view, this volume cannot be expected to deal exhaustively with any one phase of the subject. It deals succinctly but adequately with malignant tumors from the standpoint of classification, etiology, symptomology, diagnosis, pathogenesis, histology, and treatment of all the different kinds of carcinoma, sarcoma, and other varieties of tumor. The object of the book is to familiarize the medical student and general practitioner with the latest ideas on these dif-

ferent aspects of the complicated question of malignancy. The numerous illustrations include photographs showing the external appearance of many lesions, as well as photomicrographic drawings and diagrams illustrating the lymphatic drainage as applied to different kinds of tumors. Unretouched photomicrographs were not included because, as the author rightfully states, the student is unable to obtain much information from them. Therefore, the histologic illustrations are drawings carefully made from photomicrographs to bring out the essential features and to leave out all confusing detail. In dealing with the treatment of malignant tumors all the recognized forms of treatment, including surgery, roentgen rays, and radium, are mentioned and their relative merits analyzed.

In general, it may be said that the discussion of the different subjects is sane and sound. Objection might be taken to some statements if the work were more pretentious or more exhaustive, but in a book the object of which is chiefly to furnish as much information as possible in a small compass the author might be forgiven for not having mentioned certain points.

In connection with treatment the author has been at pains to discuss radiotherapy, and this part of the book is, on the whole, quite satisfactory. The methods and technic advocated are based chiefly on those used by well known French workers such as Regaud, Laborde, Ferroux and others. Although a summarized work of this kind cannot be expected to include a discussion of many details which one would expect in a more complete treatise, nevertheless it is surprising that the author has not even mentioned the value of radiography as a diagnostic procedure and as a means of identifying and classifying certain varieties of tumor. In the discussion of the various theories which have been advanced to explain the etiology of cancer, nothing has been said about the mutation theory. Also, the value of a biopsy and of microscopic examination of tissues excised for the purpose is slightly exaggerated by making it appear that the results of such examination are necessarily conclusive. Another subject which has been omitted is the diffuse endothelioma of Ewing, or endothelial myeloma of Kolodny, in connection with malignant tumors of bone. In spite of these few lapses, however, the book has achieved its primary purpose and should be of distinct usefulness to students and physicians who wish to familiarize themselves with the present status of the cancer question.

PNEUMOLYSE INTRAPLEURALE (Intrapleural Pneumolysis). By LOUIS SAYÉ, Professeur à la Faculté de mèdecine de Barcelone, Directeur du Service de l'Assistance sociale aux tuberculeux, Membre de l'Académie de médecine. Preface by Professeur LÉON BERNARD. A volume of 238 pages, with 119 figures. Published by Masson et Cie., Paris, 1932. Price, 40 francs.

Under the editorship of L. Bernard (University of Paris) a series of monographs are published, called "Bibliothèque de Phthisiologie." Although they are apparently written primarily for the physician specializing in tuberculosis, some will undoubtedly interest a wider circle of medical readers. The volume contributed by L. Sayé, Professor of Medicine at the University of Barcelona, deals with a phase of pulmonary tuberculosis therapy which has made remarkable progress during the last ten years. The technic, results, and possibilities of the cutting of adhesions within the chest by means of high frequency currents are ably discussed by the author. The work of Jacobæus and certain American authors as, for instance, Matson, is given full credit. The roentgenologist will be pleased to find numerous reproductions of roentgenograms in the text, showing the chest before and at certain intervals after the operation. Particularly instructive are the schematic drawings of the thoracoscopic picture which can thus be correlated with the roentgen findings. A bibliography of selected references on the subject is also appended. American radiologists who have mastered the French language will undoubtedly enjoy reading Sayé's monograph.

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BONE DISEASES (DIAGNOSIS)

A Rare Localization of Köhler's Disease. Curt Kremser. Röntgenpraxis, May, 1932, IV, 394-402.

Since Köhler described the so-called aseptic necrosis of the navicular bone, similar changes have been described in other bones (Perthes, Preiser, Kienböck, and others). This disease has been seen in the patella by a few authors. Two such cases are described in this article. Both were children, 5 and 8 years of age, showing complete necrosis of the patella. The clinically normal patella on the other side also showed evidence of necrotic changes. A history of trauma was not present. The differential diagnosis is usually not difficult. Tuberculosis may occasionally produce a similar clinical picture, but the roentgenogram can easily differentiate the two. In both cases the condition was cured, in one child without even putting the patient to bed.

H. W. Hefke, M.D.

Further Notes on Pituitary Basophilism. Harvey Cushing. Jour. Am. Med. Assn., July 23, 1932, XCIX, 281-284.

Twelve examples of a peculiar and clinically unmistakable polyglandular syndrome were recently reported by the author. The disorder is characterized by a rapidly acquired plethoric adiposity, affecting the face, neck, and trunk, the extremities being spared. It is associated in women with hypertrichosis and amenorrhea. Other characteristic features are vascular hypertension, purplish striæcutis distensæ of the abdomen, and acrocyanosis, with cutis marmorata of the extremities. It is often accompanied by hyperglycemia, occasionally by polycythemia, a peculiar softening of the bones of the skeleton being commonly found at autopsy. In its extreme forms, the malady has more often been encountered in young adults, and the average duration of life has been over five years. The disease in most instances has been ascribed to a primary adre-

nal disorder for the reason that cortical hyperplasia is not an uncommon postmortem observation. At autopsy five of eight cases had an unsuspected pituitary adenoma; the fact that three of them were unmistakably composed of basophilic elements made it probable that the pituitary lesion was the primary cause of the syndrome.

Roentgenologic studies showed a peculiar mottled atrophy of the bones, particularly apparent in the cranial vault. The dorsal kyphosis, associated with compression of several of the vertebral bodies, was more marked in the fifth and seventh. There were six lumbar vertebræ, two of them, the fourth more particularly, showing definite compression. In contrast to the general appearance of atrophy, the margins of the vertebral bodies appeared eburnated. The epiphyses of the long bones were normal for the age, but appeared denser than normal. The humeri and the radii showed mottling and enlargement of the trabeculæ and thinning of the cortical portions of the bones. Similar changes were present in the ribs, and surprising increase in calcium output was found. A series of high voltage roentgen treatments resulted in prompt improvement in the condition of the patient described.

C. G. SUTHERLAND, M.D.

The Roentgen Diagnosis of the Mandibular Joint. C. Parma. Röntgenpraxis, August, 1932, IV, 633-649.

The present-day diagnostic methods for diseases of the mandibular joint are still rather unreliable. In all other joints a roentgenologic examination is usually of greatest importance; however, it has not been as successful in the case of the mandibular joint, due principally to technical difficulties and the inability to obtain a good roentgenogram. The author suggests a new method.

He uses as short a focal skin distance as possible. The joint closest to the focus then appears so greatly enlarged on the film that it does not seem to show at all, and one gets good detail of the joint which is nearest the film. The projection is straight lateral, and the mouth must be kept wide open. If the patient is too close to the tube, there is, of course, the danger of electrical accidents, which can be avoided by low voltage (from 40 to 50 volts) and good grounding. The author shows on films, taken on patients and skeletons, the normal and abnormal appearances of the mandibular joint.

H. W. HEFKE, M.D.

A Case of Ochronotic Alkaptonuria, with Considerable Skeletal Changes. Ehrlich. October, 1932, IV, 865-870.

Ochronotic alkaptonuria, a comparatively rare disease, is an anomaly of the intermediary protein metabolism, with typical urinary findings. Roentgenologic findings of bone changes have been described. A case is reported, demonstrating the typical clinical and roentgenologic picture. The vertebræ and pelvis show a uniform atrophy, and the intervertebral spaces are narrowed, the discs being partially calcified. Hypertrophic changes are evident. Therapeutic methods have not been successful so far.

H. W. HEFKE, M.D.

CANCER (DIAGNOSIS)

Lung Cancer in Miners. Editorial. Jour. Am. Med. Assn., Aug. 6, 1932, XCIX, 478, 479.

Primary cancer of the lung for a long time was listed among the rare diseases; however, bronchogenic cancer has now become one of the common forms of cancer both in the clinic and the necropsy room. Prominence has been given to the Schneeberg group of cases in the Saxon mines of the Erz Mountains. In the Joachimstal mines on the Bohemian side of the Erz Mountains, only twenty miles from the Schneeberg mines and the source of the pitchblende from which the first supplies of radium were obtained for use in therapeutics, an investigation revealed that there was a high incidence of pulmonary cancer. Postmortem examination of the bodies of 13 Joachimstal miners, who died during 1929 and 1930, revealed that nine had died of primary carcinoma of the lung. In the year following, 12 miners died, in nine of whom the clinical diagnosis was pulmonary cancer. Six of the nine men had been pensioned off several years before dying of lung cancer.

Inhalation of arsenic dust might account for the Schneeberg cancer, but the facts that in both the Schneeberg and Joachimstal mines, large radium deposits exist, and that the air contains much radium emanation (up to 50 mache units), arouse the suspicion that herein lies the inciting agent of the lung cancers. The miners themselves state that the discovery of a vein rich in uranium is always followed some years later by a strongly increased mortality among them, but analysis of a part of a cancerous lung from one of the miners revealed no radioactivity, no arsenic, cobalt, or uranium.

C. G. SUTHERLAND, M.D.

CHEST (DIAGNOSIS)

Congenital Left Cystic Lung, with Aplasia of the Lower Lobe. P. Iacchia. Röntgenpraxis. October, 1932, IV, 873-878.

Marked congenital anomalies of the structure of an entire lung are comparatively rare. The author believes that some cases of bronchiectasis are of congenital origin. Usually one finds in aplasias of parts of the lung a displacement of other organs to fill the space otherwise left empty. Ring shadows may be seen in congenital cystic lungs, but an examination after intratracheal instillation of an

iodized oil will clear up the situation much more readily.

In a patient with clinical symptoms of bronchiectasis a flat chest film showed deviation of the trachea to the left, with displacement of the heart and mediastinum toward the same side. The upper portions of the left lung showed many ring-like structures. There was definite relaxation of the diaphragm, so that the stomach filled the lower portion of the left thorax. Bronchographic studies showed an absence of lung structure in the left lower lobe, there being a system of cavitations. The upper lobe contained multiple cystic areas and cavities. The thorax itself was not deformed. The pleural space was free, this being another reason for the diagnosis of congenital bronchiectasis and aplasia, rather than an acquired condition.

H. W. HEFKE, M.D.

Silicosis in a Tuberculosis Hospital. J. R. Head and S. H. Rosenblum. Jour. Am. Med. Assn., Sept. 10, 1932, XCIX, 915, 916.

A clinical and statistical study has been made in a district in which the industries do not especially predispose to pneumonoconiosis. Five hundred consecutive male patients admitted to the hospital were carefully questioned, particularly as to industrial history. Among the 500 there were 17 (3.4 per cent) who had definite silicosis. The average age was 45 years; more were under 30 years of age, the highest incidence occurring in the fifth decade. Mining and sandblasting accounted for all save one of the 17 cases (12 miners and four sandblasters), the remaining one having shoveled sand in a foundry for six years. Only four of the patients developed symptoms while still engaged in dusty work; in the other twelve there was an average interval between cessation of work and the onset of symptoms of 10.75 years, with low and high limits of four and 18 years, respectively. The average duration of exposure was eight years, with low and high limits of one and 35 years, respectively.

The roentgenogram is of first importance in the diagnosis. In this series the sputum was positive in all save five cases. If a patient has silicosis without tuberculosis, he should not be allowed in a tuberculosis hospital, much less confined there, as no other group of individuals is so susceptible to tuberculosis.

C. G. SUTHERLAND, M.D.

CHEST (GENERAL)

Massive Collapse of the Lung, with Spontaneous Pneumothorax. William H. Crede. Med. Bull. Veterans' Administration, April, 1932, VIII, 280-286.

In 1890, Pasteur reported 15 cases of massive collapse of the lungs, occurring in children who were the victims of diphtheritic paralysis. He believed that the condition is always the result of failure of respiratory power. Massive collapse was noted as a result of wounds of the chest during the World War. Cases were also reported which occurred as the result of the following: Wounds of the pelvis; myositis; inflammation of the pleura; obstruction of a bronchus by a foreign body; paralysis of the respiratory muscles; extrabronchial pressure due to neoplasms, aneurysms, or enlarged glands.

The onset of massive collapse is usually sudden, although when it occurs in a toxic tuberculous patient it may be overlooked. It is of interest that the onset of collapse may result in the relief of a previous harassing cough and that, on the other hand, if no pulmonary disease is present, a weak irritating cough may appear. Dyspnea may be present and cyanosis is not marked, as a rule.

The physical signs resemble pneumonia. In the case of collapse, however, inspection will reveal retraction or no fullness of the intercostal spaces. Displacement of the heart toward the affected side, which occurs rapidly, is noted by palpation. Absolute dullness is elicited if complete collapse of a considerable portion of lung tissue is present. This dullness may confuse collapse with the presence of fluid, but the position of the apex beat will differentiate these conditions. However, it must be checked by x-ray examination, since fluid exerting pressure may be the cause of collapse on the same side and the rather typical heart shift to the affected side may be distorted. Massive collapse produces an elevation of the diaphragm on the affected side, and, therefore, when it is present on the left an increase upward of gastric resonance occurs. Auscultation reveals absence of all breath sounds and of vocal resonance.

J. N. ANÉ, M.D.

CONTRAST MEDIA

An Unfortunate Bronchography. Björn Köhler. Acta Radiologica, 1932, XIII, Fasc. 1, pp. 54-56.

The author reports the case of a boy, 9 years old, who was studied by him. The lad had had erythema nodosum at the age of 15 months. He was subject to colds and at the age of 5 years, after having measles, developed a cough and was found to have enlarged tracheobronchial nodes. The von Pirquet was positive. At 9 years he had an acute illness, with fever and cough, which lasted more than four weeks. Because of slow convalescence and persistent cough, he was admitted to the hospital for lipiodol studies.

On two successive days lipiodol was injected (exact method not stated) in the routine way, but no opaque material could be seen in the lung fields. After three days, injection was again attempted. Roentgen examination now showed a mass of lipiodol in the central part of the neck. It reached the posterior mediastinum along the esophagus; some

of it collected along the carotids and some below the thyroid cartilage, while other portions extended outward between the subclavian artery and the brachial plexus and downward anteriorly over the pleura. During six months' observation, no change has occurred.

The author discusses the possible ways in which the lipiodol could have escaped into the soft tissues of the neck. He inclines to the opinion that a surgical emphysema occurred which opened up spaces between the fascia and layers of connective tissue and that the lipiodol worked its way into these spaces during the child's attacks of coughing.

A. L. HART, M.D.

Intravenous Pyelography with Use of Iopax. Chester D. Allen and Samuel L. Edwards. Med. Bull. Veterans' Administration, April, 1932, VIII, 277-279.

The authors discuss the indications and limitations of intravenous pyelography. Theoretically, the intravenous method of urography is ideal in all cases, for the pain and colic so often associated with the retrograde method are avoided. In those cases in which the retrograde method is impractical or impossible, the intravenous method is of considerable value, but it should never replace retrograde pyelography in the average case.

The shadows produced by the intravenous method are faint, with a considerable loss of detail in many cases. It cannot be compared to the Graham-Cole method for visualization of the gall bladder. The shadow of the gall bladder consists of simple curves, while that of the kidney pelvis is quite complicated, as the outline of the minor calyces depends on the contour of the renal papilla. The gall bladder is a single storage organ receiving the dye from the liver, while the pelves are for collection and transmission and receive the dye from the two kidneys. In certain urologic conditions the urine passes rapidly through the kidney pelves, rendering very poor visualization of the pelves in general and the minor calyces in particular.

The authors believe that the interpretation of the pyelogram should be done by the urologist and radiologist after careful discussion and consideration of all data in the case.

J. N. ANÉ, M.D.

CYSTS

Hydatid Cyst of the Lung. Alfeu Bica de Medeiros and Saint Pastous. Rev. Radiol. Clinica, February, 1932, I, 159-166.

The authors report a case of hydatid cyst of the left lung. The clinical diagnosis of cyst was supported by the laboratory and x-ray examinations and confirmed by operation. Simple small cysts are characterized in the roentgenogram by a uniformly opaque, more or less circular, area with very sharp edges. Large cysts with congestive or inflammatory reactions surrounding them are not so sharply defined. Benign and malignant tumors of the thorax and lung, encysted pleurisy, and aneurysm of the aorta give findings resembling those of hydatid cyst. Hydatid can not be differentiated from tuberculous cavities.

E. T. LEDDY, M.D.

Suprapituitary Cyst. J. H. Gibbens. Proc. Roy. Soc. Med., March, 1932, XXV, 722.

A girl, five years of age, had nocturnal attacks of headache and vomiting for a year. On roentgen examination there was found a partial destruction of the sella turcica, especially of the posterior clinoid processes. No abnormal calcification was visualized. The condition of the patient was temporarily improved following x-ray therapy.

H. C. OCHSNER, M.D.

THE ESOPHAGUS (DIAGNOSIS)

Esophageal Varices. A. Beutel. Acta Radiologica, 1932, XIII, Fasc. 5, 527-532.

Most of these cases are examined for gastric ulcer or cancer, suspected because of sudden hematemesis. Wolf, in 1928, first described two cases diagnosed at x-ray examinations. The author advises the use of a thick barium mixture which will stick in the ridges of the mucosa. The normal mucosa of the esophagus is characterized by delicate longitudinal folds. When varices are present, one sees instead wavy bands of transparency bordered by thin lines of barium. These may take a longitudinal or a horizontal direction. One also sees, occasionally, rounded areas of transparency.

The changes in the mucosal relief and contour may be confused with tumor defects, particularly the flat, scirrhous carcinoma. The fact that varices usually involve a larger portion of the esophagus than does cancer helps in the differential diagnosis. Doubtful cases should have repeated examinations. Varices also often change their form with breathing. When varices are present, the mucosal relief films of the esophagus usually show it wider than normal. The author reports two cases diagnosed by x-ray examination. One of these was confirmed by esophagoscopy; the other by both esophagoscopy and autopsy. Both of these patients had enlarged livers and spleens.

A. L. HART, M.D.